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Proceedings of International Conference on Life Science & Biological Engineering

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Proceedings of International Conference on Electrical Engineering and Computer

Science

ISBN 978-986-88450-3-9

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General Information for Conference Participants

Information and Registration

The Registration and Information Desk will be situated in the Toshi Center Hotel on the

six

th

floor, and will be open at the following times:

Saturday, March 16 (08:30-18:00)

Sunday, March 17 (08:30-18:00)

Parallel Sessions

Parallel Sessions will run on March 16 and 17 . Sessions are usually 90 minutes in

length.

Presentations and Equipment

All presentation rooms are equipped with a screen, an LCD projector, and a laptop

computer installed with PowerPoint software. You will be able to insert your USB

flash drive into the computer and double click on your presentation to open it in

PowerPoint. We recommend that you bring two copies of your presentation in case

of one fails. You may also link your own laptop computer to the projector cable,

however if you use your own Mac please ensure you have the requisite connector.

A Polite Request to All Participants

Participants are requested to arrive in a timely fashion for all addresses, whether to

their own, or to those of other presenters. Presenters are reminded that the time

slots should be divided fairly and equally between the number of presentations, and

that they should not overrun. The session chair is asked to assume this timekeeping

role.

Poster Sessions & Poster Requirements

Materials Provided by the Conference Organizer:

1. X-frame display & Base Fabric Canvases (60cm×160cm)

2. Adhesive Tapes or Clamps

Materials Prepared by the Presenters:

Home-made Poster(s)

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Requirement for the Posters:

1. Material: not limited, can be posted on the canvases

2. Size: smaller than 60cm\*160cm

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Ladkrabag

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Conference Schedule

Friday, March 15, 2013

10:30-12:00 Committee Meeting (Committee Only)

Saturday, March 16, 2013

Time Information

08:30-17:30 Registration (6F, Toshi Center Hotel)

09:00-10:30 Oral Session Room 603, Life Science I

Oral Session Room 604, Civil Engineering I

Oral Session Room 605, Electrical Engineering I

Poster Session Room 607, Poster Session

Oral Session Room 608, Business I

Oral Session Room 609, Management I

10:30-10:45 Tea Break

10:45-12:15 Oral Session Room 603, Life Science II

Oral Session Room 604, Civil Engineering II

Oral Session Room 605, Biomedical Engineering I

Poster Session Room 607, Poster Session

Oral Session Room 608, Welcome Speech/ Keynote Speech/ Politics

Oral Session Room 609, Communication / Culture

12:15-13:15 Lunch Time

13:15-14:45 Oral Session Room 603, Biological Engineering I

Oral Session Room 604, Environmental Sciences I

Oral Session Room 605, Chemical Engineering I

Poster Session Room 607, Poster Session

Oral Session Room 608, Management II

Oral Session Room 609, Psychology / Education

14:45-15:00 Tea Break

15:00-16:30 Oral Session Room 603, Computer and Information Sciences I

Oral Session Room 604, Civil Engineering III

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Oral Session Room 605, Mechanical Engineering I

Poster Session Room 607, Poster Session

Oral Session Room 608, Economics I

Oral Session Room 609, Society

16:30-16:45 Break

16:45-18:15 Oral Session Room 603, Computer and Information Sciences II

Oral Session Room 604, Civil Engineering IV

Oral Session Room 605, Mechanical Engineering II

Poster Session Room 607, Poster Session

Oral Session Room 608, Material Science and Engineering I

Oral Session Room 609, Environmental Sciences II

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Sunday, March 17, 2013

Time Information

08:30-17:30 Registration (6F, Toshi Center Hotel)

09:00-10:30 Oral Session Room 603, Life Science III

Oral Session Room 604, Mechanical Engineering III

Oral Session Room 605, Environmental Sciences III

Poster Session Room 607, Poster Session

Oral Session Room 608, Business II

Oral Session Room 609, Civil Engineering V

10:30-10:45 Tea Break

10:45-12:15 Oral Session Room 603, Life Science IV

Oral Session Room 604, Mechanical Engineering IV

Oral Session Room 605, Wireless communication / Multimedia

Poster Session Room 607, Poster Session

Oral Session Room 608, Economics II

Oral Session Room 609, Geosciences and Petroleum Engineering

12:15-13:15 Lunch Time

13:15-14:45 Oral Session Room 603, Fundamental & Applied Science

Oral Session Room 604, Electrical Engineering II

Oral Session Room 605, Chemical Engineering II

Poster Session Room 607, Poster Session

Oral Session Room 608, Management III

Oral Session Room 609, Civil Engineering VI

14:45-15:00 Tea Break

15:00-16:30 Oral Session Room 603, Biological Engineering II

Oral Session Room 604, Computer and Information Sciences III

Oral Session Room 605, Material Science and Engineering II

Poster Session Room 607, Poster Session

Oral Session Room 608, Finance

Oral Session Room 609, Computer and Information Sciences IV

16:30-16:45 Break

16:45-18:15 Oral Session Room 603, Biomedical Engineering II

Oral Session Room 604, Computer and Information Sciences V

Oral Session Room 605, Electronics Engineering

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Poster Session Room 607, Poster Session

Oral Session Room 608, Life Science V

Oral Session Room 609, Civil Engineering VII

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Toshi Center Hotel

Access to the Toshi Center Hotel

 4 minute-walk from Exit No.1 of Kojimachi station, Yurakucho Subway Line.

 4 minute-walk from Exit No.4 or 5 of Nagatacho Station, Yurakucho/Hanzomon Subway

Lines.

 3 minute-walk from Exit No.9 of Nagatacho Station,Nanboku Subway Line.

 8 minute-walk from Exit D of Akasaka Mitsuke Station,Marunouchi / Ginza Subway

Lines.

 14 minute-walk from Kojimachi exit of Yotsuya Station, JR Chuo Line.

 By bus, Hirakawacho 2-chome Toshi Center-mae.

(Shinbashi - Ichigaya - Kotakibashi Shako route)

 By car, five minutes from kasumigaseki exit, Shuto Expressway.

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Program - Oral Sessions

Life Science I

2013/03/16 Saturday 09:00-10:30 Room 603

Session Chair: Mohd Effendy Abd Wahid

LSBE 053

Response of serum IgG upon intranasal inoculation of

Exopolysaccharides-adjuvanted vaccine of Pasteurella multocida B:2 in Winstar

rats

Mohd Effendy Abd Wahid︱Universiti Malaysia Terengganu

M.A.K. Sharzehan︱Universiti Malaysia Terengganu

LSBE 054

Investigation of exposure radiation dose for periapical inter-oral dental X-Ray

Examination

Edrees M. Tahir Nury︱University of Salahaddin-Hawler

Bayan Saber Ibrahim︱Hawler Medical University

Hewa Y. Abdullah︱University of Salahaddin-Hawler

LSBE 055

Investigation of Protein-Protein Interaction and its Possible Role in the

Formation of Amyloid Fibrils

Sheeren I. Hajee︱Hawler Medical University

Edrees M. T.Harki︱Salahadden-Hawler University

LSBE 074

Reproductive success of Eurytemora affinis is unaffected during a

diatom-dominated spring bloom

Roswati Md Amin︱Universiti Malaysia Terengganu

Ulf Båmstedt︱Umeå University

Carsten Paul︱Friedrich Schiller University Jena

Larysa Samchyshyna︱Research Cent re of Ecomonitoring and Biodiversity of

Megalopolis NASU, Ukraine

Elin Lindehoff︱ Umeå University

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Georg Pohnert︱Friedrich Schiller University Jena

LSBE 386

The study on influence to Cortisol concentration of dwellers for the indoor life

space in the disaster prevention tents with causing environmental factors

Kazuo Fukushima︱Kyusyu University

Takayuki NISHIMURA︱Kyusyu University

Yosuke Nisato︱Kyusyu University

Midori MOTOＩ︱Kyusyu University

Shigeki WATANUKI︱Kyusyu University

LSBE 307

Changes of peripheral benzodiazepine receptor gene expression in major

depressive disorder and methamphetamine dependence

Siriluk Weerasakul︱Naresuan University

Namtip Tubtimtong︱Naresuan University

Paritat Watiktinkorn︱Synphaet Hospital

Samur Thanoi︱Naresuan University

Sutisa Nudmamud-Thanoi︱Naresuan University

LSBE 262

Leaf Anatomy and Pollen Studies of Zingiberaceae in Lambusango Wildlife

Reserve, Buton Island, Indonesia

Gufrin Amlin︱University of Technologi MARA

Rita Ningsih︱University of Haluoleo

Mohd Nazip Suratman︱University of Teknologi MARA

Nurun Nadhirah Md Isa︱University of Teknologi MARA

Axel Dalberg Poulsen︱University of Oslo

Indrawati Indrawati︱University of Haluoleo

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LSBE053

Response of serum IgG upon intranasal inoculation of

Exopolysaccharides-adjuvanted vaccine of Pasteurella multocida B:2

in Winstar rats

\*

Effendy, A.W.M.

1

1

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2

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Department of Biological Science, Faculty of Science and Technology, Universiti

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Abstract

1. Objective

The study was conducted to determine the efficacy of exopolysaccharides

(EPS)-adjuvanted intranasal vaccine of formalin-killed of Pasteurella multocida B:2

in white rats.

2. Materials and Methods

Twelve clinically healthy Winstar rats were divided equally into four groups. Group

1 was intranasally inoculated with EPS-adjuvanted formalin killed Pasteurella

multocida B:2 at 1.41 × 10

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CFU/mL while Group 2 with P multocida B:2 in sterile

PBS with the same bacterial load. Group 3 was intra-nasally administered with EPS

extracts while Group 4 remain as control untreated group. All treated groups were

given booster vaccination intra-nasally at two weeks internal. Two weeks after the

booster vaccination, all animals were challenged with intra-peritoneal injection of live

Pasteurella multocida B:2 at 10

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CFU/mL. Serum was collected from all animals

every week to determine the level of IgG. Seven days after the challenge, all animals

were euthanized and bacterial isolation was done from heart, lungs, liver and kidney

upon post-mortem examination.

3. Results

Based on statistical analysis using ANOVA and T -test, significant level (p<0.05) of

IgG was observed in the EPS-adjuvanted vaccine group when compared with other

groups (Figure 1). The lesions were less severe in EPS-adjuvanted vaccine group

compared to others. Pasteurella multocida B:2 were successfully re-isolated from

all organs of animals in Group 3 and Group 4 that died at day-4 post-challenge.

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4. Conclusion

Therefore, EPS-adjuvanted vaccine is effective to be used as potential adjuvant for

intranasal vaccination against Pasteurella multocida B:2 infection.

5. Acknowledgements

The author wish to acknowledge the Institute of Marine Biotechnology, Universiti

Malaysia Terengganu for providing the facilities to run the experiment.

Figure 1: The development of serum IgG antibody response in Winstar white rats for

each week.

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LSBE054

Investigation of exposure radiation dose for periapical intra-oral

dental X-Ray Examination

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Email :kuhewa@yahoo.com

The corresponding author:HewaYaseen Abdullah

Abstract

The aim of this study is to estimate the radiation dose for children and to compare this

estimate with the radiation dose experienced by adults arising from peripical intra-oral diagnostic exposure In addition, a comparison will be made between the

maxillary and mandibular molers.In this study, ESD was measured using

LiFthermoluminescent dosimeters (TLD-100) on the skin (either mandibular or

maxillary arcs) of all patients. Monte Carlo simulation was performed to estimate an

effective dose (ED) by using PCXMC Dose Calculation software. A wide distribution

of doses has been obtained. A higher value mean±SD of ESD is recorded for

maxillary molar (3.678±1.868) mGy for the (31-60 year) age group and the lowest

value is recorded for mandibular molar (2.090±1.061) mGy for (1-15 year ) age group.

As well, a higher mean value of ED is recorded for mandibular molar, (4.998) µSv for

the (1-15 year) group, but the lowest value (2.673) µSv is recorded for mandibular

molar for the (16-31year) group.The ESD for maxillary molar is more than the ESD

for mandibular molar for all age groups. In general, a wide distribution of doses has

been obtained which are in good agreement with others, especially with EU.

Keyword: radiation dose,periapical inter-oral, entrance surface dose, effective

1. Introduction

Medical diagnostic X-rays represent the largest doses of man-made radiation. Dental

radiology accounts for about 25% of all world-wide examinations,and intra-oral

dental radiology represent almost 90% of the total explorations performed in

dentistry[1]. When patients undergo X-ray examinations, millions of photons pass

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through their bodies. The ionization by these photonscan do damage to any part of the

cells molecular structure but damage to the DNA in the chromosomes is of particular

importance. Most DNA damage is repaired immediately, but on rare occasions a

portion of a chromosome may be permanently altered (a mutation). This may lead

ultimately to the formation of a tumor[2].

In recent years concern has been raised over the hazards of exposure to small doses of

ionizing radiation[3,4]. Although radiation doses in dental radiography are low, the

probability of a fatal cancer being induced in an individual patient from a single X-ray

examinationis dependent on the age of the patient and the type of examination[5].The

risk for pediatric patients that undergo X-ray examinations is higher than that of

adults because their cells, tissues and organs have higher radio sensitivity. Exposure

during childhood may result in a two- to three-fold increase in lifetime risk for certain

detrimental cancers compared with adults [6]. The European Commission (EC) [7]

states that ‘radiation exposure in the first 10 years of life is estimated to have a risk

about 4 times greater than exposures incurred at 30–40 years of age for some

detrimental effects’. It is important that the radiation dose to children arising from

diagnostic medical exposure is minimized.

To assess the probability of health impairment from low doses of ionizing radiation,

the International Commission on Radiation Protection (ICRP) proposed a theoretical

quantity in 1975. This quantity was initially known as effective dose equivalent and

became known as effective dose(ED) in 1990. This quantity gauges the health risk

(fatal and nonfatal cancers, taking into account the latency period as well as severe

hereditary disorders) of a “standard” patient who is not uniformly exposed to ionizing

radiation and transposes it into a situation in which this patient would be uniformly

exposed to a radiation field. Effective Dose(ED), which is the same unit as an

equivalent dose, is obtained by summing individual organ equivalent doses (HT)

multiplied by the corresponding tissue weighting factors.

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Where WT is dimensionless tissue weighting factors characterizing the relative

sensitivity of various tissues with respect to endpoints such as cancer induction and

mortality [8]. The most appropriate method for ED calculation is the Monte Carlo

simulation of radiography accompanied by measurements of entrance surface dose

(ESD) or dose area product (DAP). Similar practices have been followed by many

surveys [2,5] regarding the risk to children from simple X-ray examinations.

The aim of this study was to estimate the radiation dose for children and to compare

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this dose with the radiation dose given to adultsduring Pediatric and adult periapical

inter-oral dental X-Ray Examinations.

2. Methods

This study was carried out in the Dental College clinical hospitals in Erbil city. A total

of 021 patients were divided into three age groups, (1-15),(16-30) and(31-60) and

further divided based on sex, weight, height, thickness and technical parameters. Tube

Voltage kVp, current-time product mAs ,FFD)were recorded. The Entrance Surface

Dose (ESD) for each patient involved in periapical inter-oral dental X-Ray

Examination was measured by using Thermolumence Dosimeter (TLD). In this study

the Monte Carlo simulation was performed to estimate effective dose (ED) by using

PCXMC Dose Calculation software copyright STUK 2004.

3. Result and Discussion

The technique factors kVp,mA and Time/sec with FFD focal to film distance,

mean±SD for each patient age group as well as the overall mean ESD±SD for

maxillary and mandibular intra-oral radiographies are shown in table (1). The

distribution of ESDs measured at the center of the beam in intra-oral examinations for

maxillary and mandibular is shown in figures (1) and (2), respectively.

The highest mean ESD±SDwere measured on the maxillary (3.678±1.868

mGy)formean age ±SDgroup (45.833±7.250 years) and the lowest mean ESD±SD

were measured on the maxillary(2.775±0.822 mGy) for mean age±SD group

(24.333±8.846 years). In addition, the highest mean ESD±SD were measured on the

mandibular (2.304±1.328mGy) for mean age±SD group (26.833±6.645years) while

the lowest mean ESD±SDwere measured on the mandibular(2.090±1.061mGy) for

mean age±SD group (8.833±3.188years).Table (2) shows the range of maximum,

minimum, Max/Min and median effective dose ED/μSv for maxillary and mandibular

periapical inter-oral dental X-Ray Examination of three age groups (1-15, 16-30 and

31-60) years. Note that the maximum valuesrecorded were 4.998μSv for mandibular

inter-oral X-ray examination for patients in the 1-15 years age group,and the

minimum value of2.673μSv was recorded for mandibular inter–oral X-ray

examination for patients 16-35 years age group.

The overall results of this study indicate that exposure of the patients at the Dental

Radiology Department of Hawler University of Medical Sciences does not exceed the

levels either reported by Gonzalez et al. [9] using thermoluminescent dosimeters,

based on data collected from over 300 intraoral X-ray facilities. They proposed a

provisional local reference level of 3.5 mGy entrance surface dose for intraoral

radiology.As indicated before, IAEA has proposed a diagnosticreference level value

8

of 7 mGy for intraoral radiographies.Also, the ESD for maxillary molar is more than

the ESD for mandibular molar for all age groups. In general a wide distribution of

doses were obtained and all were in good agreement with other results, especially

with EU[10,11].

Table(1): The technique factors kVp ,mA and Time/sec with FFD/cm focal to film

distance, mean±SD for age of patient and the overall mean ESD (±SD) for

maxillary and mandibular intraoral radiographies.

Age(year) kVp mA Time/sec FFD/cm ESD(mGy)

8.833±2.562 Maxillary 65 20 0.5 23 3.148±1.298

8.833±3.188 Mandibular 65 20 0.5 23 2.090±1.061

24.333±8.846 Maxillary 65 20 0.6 23 2.775±0.822

26.833±6.645 Mandibular 65 20 0.6 23 2.304±1.328

45.833±7.250 Maxillary 65 20 0.6 23 3.678±1.868

48.000±9.402 Mandibular 65 20 0.6 23 2.210±1.351

Table (2):The rangeand median of effective dose ED/μSv for maxillary and

mandibular periapical inter-oral dental X-Ray Examination of three age groups (1-15,

16-30 and 31-60) years.

Age Group Typeof

examination

Range

Max Min

Max/Min Median

01-15 year

16-30 year

31-60 year

Maxillary

Mandibular

Maxillary

Mandibular

Maxillary

Mandibular

4.781 3.226

8.695 2.428

4.876 1.681

5.236 1.058

8.54 2.625

6.274 0.906

1.482

3.581

2.900

4.948

3.253

6.924

3.734

4.998

3.217

2.673

4.873

2.997

9

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11

LSBE055

Investigation of Protein-Protein Interaction and its Possible Role in

the Formation of Amyloid Fibrils

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Abstract

The main goal of this study is the investigation of protein-protein interaction and its

effect on aggregation as well as amyloid fibril formation, and its possible role in

controlling and inhibiting the formation of amyloid fibrils. To accomplish this, the

study was done through the effect of temperature, trehalose, glycerol and L-arginine

on BSA-BSA interaction by using SLS and Turbidity. It is observed that

L-arginine takes the first place arrangement in reducing turbidity, followed by

glycerin, with trehalose taking third place. Finally, a second step in this study was

using Cong Red (CR) binding spectroscopy technique in detecting amyloid fibril

formation. Amyloid fibril was formed from BSA under 70oC. In this part of the

study,it was observed that arginine has a great ability to suppress BSA amyloid fibril

when (L-arginine, glycerin, trehalose) were tested.

Keyword:protein-protein interaction,protein aggregation, SLS,Turbidity and amyloid

fibril

[1] Introduction

Amyloidosis are protein deposition diseases of which the more well known are

Alzheimer’s disease, Huntington’s disease, Bovine Spongiform Encephalopathy,

familial amyloid polyneuropathy and Parkinson’s disease [1,2].

It is generally accepted that amyloid formation is usually the result of misfolded and

partially unfolded states acting in competition with the normal folding pathways. The

best way to research amyloid formation is by studying the protein-protein interaction,

and it has been known for many years that the osmotic second virial coefficients of

B22

are very useful properties when studying the interaction between protein molecules

in aqueous solutions [3,4], the osmotic second virial coefficients (B

22

) of protein

12

solutions have generated a great deal of interest since George and Wilson showed the

correlation between the ability of proteins to crystallize and B

22

, which is a

thermodynamic parameter that characterizes protein-protein interactions. Positive B

22

values indicate predominantly repulsive intermolecular interactions and the protein in

the native state, whereas negative values reflect predominantly attractive interactions

and the protein will be unfolding or partially unfolded. B

22

correlates to protein

stability (as seen in aggregation behavior) and solubility by accounting for the

contribution of electrostatics, Vander Waals interactions, excluded volumes, hydration

forces, and hydrophobic effects, the same interactions that regulate protein phase

behavior [5]. In addition to pH and ionic strength, there are several factors such as

temperature, protein concentration in solution and the presence of additives that affect

the value of B

22

[6].

[2] Methods

A stock solution of 0.1M Sodium phophate buffer PH7 was prepared, filtered with a

syringe (using 0.22m, 4mm Millex Milipore syringe), and the concentration was

determined spectrophotometrically (using ε (1%,1cm,280nm) = 6.67 for BSA. BSA

stock solution was prepared in the buffer solutions at 5 different concentrations

ranging from (1 -5) mg/ml. All concentration samples were heated for 60 min from

(25 – 80( ْc (5 degree interval). Static light scattering measurement for obtaining the

second virial coefficient B22,were performed using a modulated photo detector with

He-Ne laser(λ=632.8nm, 1mW) from PHYWE, model 08181.934#17530. Typically,

4-5 dilutions of a particular protein stock were filtered directly into the scattering cell.

The incident light source was vertically polarized. Relative scattering intensities in

excess of background (solvent, stray light) were converted to absolute scattering

intensities(R

90) by calibrating the instrument response using toluene as calibration

standard (R

90

=14.0x10-6 cm-1 at 632.8nm).Static light scattering data was analyzed

based on the classical Zimm equation (Eq.1) [7] :

) 1 ....( .......... .......,.. 2

1

22

0

   C B

M R

C K

w 

where Rθ is the Rayleigh ratio at angle θ (θ = 90°),

Mw is the molecular weight of protein, and C its concentration in g/ml. The constant

K0 is given by

) 2 ( .......... .......... .......... ) (

4

2

4

2 2

0

dc

dn

N

n

K

o A

o







where n0 is the refractive index of the solvent, N

A

is the Avogadro number, and (dn/dc)

is the specific refractive index increment of the protein solution. Extrapolating the

(dn/dc) values at 436 and 589 nm , using a linear regression (dn/dc) albumin at

632.8 nm was found to be 0.185 ml/g.

A plot of KC/R90 versus C (concentration g/ml) resulted in a straight line, and from

13

the slope of the straight line the value of B22 can be found. The intercept of this

straight line (1/MW) gives the molecular weight of the protein.The same steps as

above were repeated in the presence of 0.5M L-arginine, 20% of glycerol, 0.2M

trehalose. To measure turbidity an HACH 2100N turbidometer were used,and protein

solution was prepared as follows: BSA protein was dissolved in 0.1M phosphate

buffer containing 0.05% (w/v) sodium azide, filtering protein buffer solution with

0.22μm filter. The final BSA protein concentration was measured

spectrophotometrically and was typically around 20 mg/ml. Next, an appropriate

amount of trehalose, L-arginine, and glycerol was added into the solution separately

and the solutions were stirred to ensure that the excipients were completely dissolved.

Protein solution with and without excipients are prepared separately for each

experimental run.Turbidity was measured for each sample after heating the sample for

60 min.

Finally,to study the formation of Amyloid fibril, the protein was prepared as

follows:BSA was first dissolved in buffer at pH 7.0 containing 100mM NaCl to make

a stock solution, which was diluted into buffer at pH 7.0 containing 100 mM NaCl

and 0.05% (w/v) NaN3 in the absence or in the presence of glycerol 20%, trehalose

0.2M, and L-arginine 0.5M. Each protein solution was prepared separately in its

own volumetric flask.20 ml of the protein at a final concentration of 20mg/ml in the

absence and presence of glycerol 20%, trehalose 0.5M, L-arginine 0.5M were put in a

glass vial with a tide screw cap and put in an incubator under various experimental

conditions at 70oC for up to 20 days. After a daily 5min. stir, samples were taken out

at intervals and stored on ice before adding CR solution.Congo red binding assay was

done according to the procedure described in [8,9], the binding of CR to several

purified amyloid like peptides having a β- plated sheet conformation was

quantitatively examined. CR binds preferentially to the β-plated sheet conformation as

CR does not bind nearly so well to native protein conformation. A stock solution of

200μM congo red was prepared in 0.1M phosphate buffer pH 7 containing 100mM

NaCl and 10%(v/v) ethanol. The CR solution was filtered through a 0.22μm pore size

filter before use. In a typical assay, the protein sample was mixed with a solution of

CR to yield a final CR concentration of 10μM and a final protein concentration of

1-3μM, and then incubated at room temperature for at least 30min in the dark before

recording the absorbance spectrum.

[3] Result and Discussion

Fig (1)and (2)show the results of B22

and molecular weight variation with changes in

temperatures for BSA. It is observed that the repulsion between protein molecules

decreases with increasing temperature when starting with native protein, in addition to

reversing repulsive interaction between protein molecules to attraction. Two transition

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temperatures werealso obtained. The first transition occurred below 55 o C and the

second transition temperature occurred at a temperature of 70

o

C. The first transition

temperature is a minor transition, while the second transition is a major one,

corresponding to the thermal unfolding of albumin. Multi transition temperature is an

indication of the presence of intermediates in the melting profile of the protein.

Population regression coefficient its 88.87 % temperature change, a very high and

significant difference obtained due to the effect of temperature on B

22

value.The result

of the effect of an additive consisting of 0.5M L-arginine, 20% of glycerol, 0.2M

trehalose on protein-protein interaction under the influence of temperaturewas

studied.The population regression coefficient for B

22

against temperature for a BSA

solution containing 0.5M L-arginine, 20% of glycerol, 0.2M trehalose is

5.79%,69.33%,and82.94%,respectively. In addition, highly significant differences

were obtained when changes in molecular weight against temperature for BSA

solution in the presence of L-arginine were compared with BSA solution in the

absence of arginine. No significant difference was obtained when an unpaired student

t-test was used to compare molecular weight for BSA solutions with and without 20%

glycerol and 0.2M trehalose, under the effect of temperature.

Another method used in this study to detect heat induced aggregation for BSA is by

measuring turbidity at different temperatures. Fig (3)show the result of turbidity for

BSA in 0.1M phosphate buffer pH 7, in the absence and presence of 0.5M

L-arginine, 20% Glucose and 0.2M trehalose, heated from 35-800C, 5 degree

intervals for 60 mins, the same condition as in SLS method. At the absence of additive

It was observed that the turbidity is approximately constant at temperatures between

25-55

o

C with a value of 3.89 at 25

o

C; at temperatures greater than 55

o

C the turbidity

increases gradually till 70oC;and ata temperature of 70

o

C the amount of turbidity

increases more rapidly and reaches 46.7 at 80

o

C. Turbidity results confirm those

obtained from the SLS measurement showing the transition temperature as 55

o

C and

70

o

C, and it was also observed that heat induced aggregation occurs at temperatures

of 70

o

C and above. A highly significant difference of 65.95% confident, population

regression coefficient its 65.95% temperature changes. Unpaired student t-test was

used to compare the result of turbidity at (40-55)

o

C and the amount of turbidity at

temperatures between (55- 80)

o

C, and significant differences were observed. As well,

concerning 0.5M L-arginine, the results show no significant difference at

temperatures of (40-55)

o

C, but a very significant difference is seen at a temperature

range of (60-80)

o

C when compared with the turbidity of BSA in the absence of

l-arginine at the same temperature. When glycerol is present, no significant difference

at (40-60)

o

C was obtained, while a highly significant difference was obtained at

(65-80)

o

C, indicating that increasing percentages of glycerol leads to decreases in

aggregation percentage.

15

Congo red absorbance spectroscopy was utilized to probe for the presence of cross-β-pleated sheet structures associated with amyloid. It shifted the spectral properties of

Congo red and exhibited a second shoulder peak at 540nm, which is indicative of

strong binding between BSA and Congo red dye and the generation of an appreciable

amount of amyloid fibrils. Identification of the amyloid-like fibrils- Congo red is a

useful dye to detect the formation of amyloid fibril(s) [10]. Congo red has been shown

to bind preferentially to aggregate peptides/proteins of amyloid but not to the native,

unassembled forms [10]. We performed the Congo red binding experiments to see if

the aggregates of BSA formed at higher temperatures (>50

o

C) have amyloid fibril

characteristics. The absorption intensity of Congo red at 487nm shifts to an absorption

intensity of 540nm when BSA in 0.1M phosphate buffer was incubated at 70

o

C for 30

days. Significant red shift is observed in the absorption spectrum when the dye binds

to the protein in the order, intermolecular β-pleated sheet structure of the amyloid

fibrils see Fig (4), which illustrates the intensity of the absorption peak of Congo red

(487 nm), Congo red binding with incubated BSA (appearance of peak at 502nm with

shoulder at 540 nm), and also when bonded Congo red was filtered the absorbance

peak was 527 nm. The absorption peak of native BSA with CR was 497nm.

It is observed that the absorbance peak of CR decreases and reaches 498.17 nm at

20% glycerol, while the shoulder peak remains within the spectrum but with a lower

value. The absorbance peak and the existence of shoulder are tabulated in Table (1).

In Fig (4) it was observed that the presence of L-arginine leads to a decrease in

absorbance peak with a lack of shoulder peak at ~ 540 nm in the Congo red binding

absorbance spectrum.No appreciable amount of amyloid was observed in the BSA

sample with 0.5M L-arginine. No effect of trehalose was observed when added to

protein solution as seen in Fig (4).

Nevertheless, it is our belief that the outcome of this work will enable us not only to

comprehend the mechanism(s) of amyloid protein, disease-related or

non-disease-related, self-association process, but also to aid in developing potential

targets for molecular therapeutics in the prevention or retardation of amyloid

formation implicated in amyloidogenic diseases.

16

Fig (3) The value of turbidity against Temperature, for BSA, BSA+0.2M trehalose,

BSA+ 20%glycerol, BSA+ 0.25M L-arginine and BSA+ 0.5M L-arginine.

Table [1]:Absorption spectrum peak of CR at different solution condition Absorbance

peak (nm)

CR 487.52

CR+Native BSA 498.45

Filtered (CR+incubated BSA) 527.81

Unfiltered (CR+incubated BSA) 527.81+ shoulder peak at 540 nm

CR+incubated (BSA+0.2M Trehalose) 507.54 + shoulder peak at 540 nm

CR+incubated (BSA+ 20% glycerol) 498.17 with shoulder

CR+(BSA +0.5M L-arginine) 499.98 with small shoulder

Fig (1) B

22 value against Temperature, for BSA,

BSA+0.2M trehalose, BSA+ 20%glycerol, and BSA+

0.5M L-arginine.

Fig (2) Molecular weight value against Temperature,

for BSA, BSA+0.2M trehalose, BSA+

20%glycerol, and BSA+ 0.5M L-arginine.

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Fig (4 )Congo red binding assays to characterize the effects of (20% glycerol, 0.5M

L-arginine, and 0.2M trehalose) respectively on BSA amyloid fibrils

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400.0 450 500 550 600 650 700.0

0.37

0.6

0.8

1.0

1.2

1.4

1.60

nm

A

502.64

527.81

498.45

487.52

\_\_\_\_\_\_\_ Congo red

\_\_\_\_\_\_\_ filtered( incubated BSA + Congo red )

\_\_\_\_\_\_\_ unfiltered (incubated BSA+ Congo red)

\_\_\_\_\_\_\_ native BSA+ Congo red

\_\_\_\_\_\_\_ Congo red binding

\_\_\_\_\_\_\_ unfiltered (incubated BSA + Congo red)

\_\_\_\_\_\_\_ filtered (incubated BSA + Congo red)

\_\_\_\_\_\_\_ unfiltered [(incubated BSA+ 20% glycerol) +Congo red]

\_\_\_\_\_\_ Congo red

\_\_\_\_\_\_ native BSA + Congo red

\_\_\_\_\_\_ unfiltered (incubated BSA + Congo red)

\_\_\_\_\_\_ unfiltered [incubated BSA +0.5 M L-arginine) + Congo red]

\_\_\_\_\_\_\_\_ Congo red

\_\_\_\_\_\_\_\_filtered (incubated BSA + Congo red)

\_\_\_\_\_\_\_\_ unfiltered (incubated BSA + Congo red )

\_\_\_\_\_\_\_\_ unfiltered [incubated (BSA + 0.2M trehalose) + Congo red]

\_\_\_\_\_\_\_\_ unfiltered (native BSA + Congo red)

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LSBE074

Reproductive success of Eurytemora affinis is unaffected during a

diatom-dominated spring bloom

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Abstract

Egg and naupliar production of copepod Eurytemora affinis, were determined over a

period of 20 days (11–31 May, 2010) while fed water from 3 differently treated and

untreated natural water. Two of the mesocosms were inoculated with Skeletonema

marinoi strains producing different particulate polyunsaturated aldehydes (PUA) and

one mesocosm with dissolved polyunsaturated aldehyde. The aim was to investigate if

the potential effectscaused by different strains of the dominant diatom and/or only

related to the level of metabolites (dissolved PUA) in the water. Egg production rate

20

of Eurytemora affinis mainly related to food availability, increased with increasing

chlorophyll a concentration and mineral content of the water, but was not affected by

the observed high particulate (up to 28 nmol L

-1

) PUA production and dissolved (up to

278 nmol L

-1

) metabolite in the water. However, the naupliar production was not

affected by either aldehydes in the maternal diet or exposure to the dissolved

aldehydes in the water. We suggest that Skeletonema marinoi did not play a

significant role in determining the succession of Eurytemora affinis in the

experiments.

Keywords: Eurytemora affinis, egg production, mesocosm, toxic aldehydes

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LSBE386

The study on influence to the Cortisol concentration of dwellers for

the indoor life space in the disaster prevention tents with causing

environmental factors

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Abstract

The purpose of the study is to elucidate the Cortisol concentration during the first

day and the last day in the disaster prevention tents with improving the amenity of

dwelling people.

And we analyzed the relation between the Cortisol concentration data and

environmental factors.

As the methods, the different five types of the disaster prevention tents accommodated

each five subjects with a sum of twenty five persons. On the morning of the first day

22

and the last day during ten days, we collected the saliva of dwellers to research the

Cortisol concentration with ELISA analyzing kits(No:EA65,Oxford Biomedical

Research ,USA) . And we measured the temperature, the humidity and the CO2

concentration in each of the tents. Continuously we had dealt with two factors

analysis of variance and got the data between the Cortisol concentration values and

environmental factors. In case of interaction data we conducted multiple regression

analysis for them.

Results were the followings.

We studied to effect the Cortisol concentration values of structural factors in tents.

We dealt with two factors analysis of variance with the conditions(five types tents)

and time factors(the first day, the last day).The time factors had main effect on Cortisol

concentration We were confident that the Cortisol concentration significantly

increased at the last day than the first day. On the case of detail Analysis, the Cortisol

concentration had the interaction for environmental factors. In the multiple regression

analysis between the independent variable of the environmental factors and the

dependent variable of the Cortisol concentration, each of the humidity and the cubic

capacity per person(m

3

/a person) decreased with the Cortisol concentration

increasing.

Consequently the cubic capacity per person(m

3

/a person) and the humidity are

important factors to improve the amenity of the disaster prevention tents on the

condition of long time lapse and tent life. The humidity had influence to Cortisol

concentration independently without the cubic capacity per person(m

3

/a person).

Key words: tent , amenity, Cortisol, QOL

1. Introduction

In case of occurring the catastrophe, the disaster prevention tents will have the

necessity of constructing temporary living space. Generally some researchers

1)－3)

have submitted the stress of long terms for tents lives with disadvantage

environment and discomfort surroundings. The evaluation of ordinary houses and

common rooms have been reported amenity and comfort by the several

researchers

4)－7)

.

But there are the difference structures and functions between the ordinary houses

and the disaster prevention tents . We can’t apply the evaluation of the

ordinary houses.

We need the new evaluation standards of the comfort and stress for tents living

space.

2. Objectives

The purpose of the study is to elucidate the Cortisol concentration during the

23

first day and the last day in the disaster prevention tents with improving the

amenity and the stress for dwellers. We analyzed the relation between the Cortisol

concentration as the physiological marker and the environmental factors. The

environmental factors means the aspect ratio, the square capacity per person (㎡/a

person),the cubic capacity per person (m

3

/ a person), temperature, humidity and

CO2

concentration in the tents.

3. Methods

3.1 Subjects

The five types tents (A,B,C,D,E:Figure1) have each different environments

and the conditions of living space. A type tent had thirty dwellers. B type

tent had twenty dwellers. The each C,D,E types tents had each six dwellers . The

total person of them are sixty eight persons. We chose each five persons

subjects to each A,B,C,D,E tents within total persons. The total of twenty five

persons subjects(29±5.4 years old) were not to drink alcohol and were not to

smokers.

3.2 Experimental condition

The disaster prevention tents for the experiment were shown by Figure 1，they

had each different sizes , structures and shapes of formation. These tents are the

differences of 4 types. A type tents and B type tents were composed of three

times of C type tents. Each type tents have the different conditions of tents

which are sizes, structures, shapes.

There are dwellers with twelve persons more than standard capacity persons

in A type tent. The dwellers of B type tent were more two persons than standard

capacity persons. The dwellers of each C type, D type. E type tents had each six

persons with the standard capacity persons. The table 1 shows the aspect ratio,

the square capacity per person(㎡/a person) and the cubic capacity per person(m

3

/ a person) in the tents. The table 2 shows temperatures, humidity and CO

2

concentration in the tents at the first day morning and last day morning.

3.3 The procedure of experiment(Protocol)

The terms of experiments had taken ten days from the last week of January

to the middle week of February. The measurement of environmental factors and

collecting saliva in the tents were conducted at seven o’clock in the morning of

the first day and the last day. The subjects in the tents were to get up at six and

thirty minutes o’clock in the morning. They gargled and sat down on the

collapsible beds for twenty minutes .And then, they were collected the saliva.

24

3.4 The measurement of the environmental factors

The environmental factors include structural factors〔Table 1:the aspect ratio,

the square capacity per person(㎡/a person) and the cubic capacity per person(m

3

/ a person) 〕 and physical－chemical factors〔Table 2: temperatures, humidity

and CO

2

concentration〕 in the tents. The temperature and the humidity in

the tents were measured with automatic temperature and humidity measuring

equipment(TR72,ST&D Inc.). The CO

2 concentration were measured with CO

2

concentration measuring test tube(GASTEC 1MO4GV100SJ1,Gastec Inc.). The

location and position of measuring point for the temperature, humidity and CO

2

concentration was the center of the tents spaces.

3.5. The collection of saliva

We have used the salivette tube

(salivette,No51,1534,Sarstdt,Numbrecht,Germany) to collect saliva of subjects

persons for two minutes. After collecting the saliva,we had revolved the cyclone

separator into the saliva to exclude microorganisms and cells from saliva. We

dealt with the cyclone separator ( at 3500rpm for 15 minutes). Continuously

we weighed the salivas on the scales. We calculated the volumes of

salivas(ml/minute).

3.6. The analysis of saliva－Cortisol

concentration(Abbreviation :Cortisol concentration)

we analyzed Cortisol concentration (μｇ/ｍｌ) with ELISA Kit

(Enzyme Immunoassay for Cortisol, Product No.EA65,Oxford Biomedical

Research ,USA).

We made the 100 times dilution of the saliva and analyzed them.

3.7. The process of Data and statistics analysis

We analyzed the Data and statistics with SPSS ver,7.0 J(Japan Inc. Tokyo).

After having dealt with the Cortisol concentration ,we conducted two factors

analysis of variance with the conditions (five types tents) and times factors(the

first day, the last day). The Cortisol concentration had the interaction for

structural factors. Continuously we conducted the multiple regression analysis

between the independent variable of the environmental factors and dependent

variable of the Cortisol concentration.

4. Result & Discussion

4.1. Result

The result of each environmental factors (structural factors, physical－

chemical factors) in each tents shows Table 1 and Table 2.

25

There were difference values of measurement for temperatures, humidity, CO2

concentration between the first day and the last day.

First of all, we conducted two factors analysis of variance with the

conditions(five type tents) and times factors(the first day, the last day). The time

factors on the Cortisol concentration had main effect ［F(1 ，23)＝45.072 ，ｐ＜

0.01］．We were confident that the

the Cortisol concentration significantly increased(ｐ＜0.01) at the last day

than the first day(Figure 2). On the case of detail analysis, the Cortisol

concentration had the interaction for environmental factors［F(4，20)＝

3.017，ｐ＜0.05］．

As we analyzed the interaction for the Cortisol concentration on times

factors in detail and the relation of environmental factors. We elucidated the

relation between the Cortisol concentration and the environmental factors

〔the aspect ratio, the square capacity per person (㎡/a person),the cubic capacity

per person (m

3

/ a person), temperature, humidity and CO

2

concentration〕. We

conducted the multiple regression analysis between the independent variable of

environmental factors and the dependent variable of the Cortisol concentration.

And then , the result showed Table 3. The Cortisol concentration had

significantly each negative partial correlations with cubic capacity per persons

(m

3

/ a person)〔Pr＝－0.83，ｐ＜0.01〕and humidity 〔Pr＝－0.39，ｐ＜

0.01〕.

4.2. Discussion

We had studied to improve the amenity and QOL of the disaster prevention tents,

we measured the Cortisol concentration of the first day and the last day for

ten days. We conducted two factors analysis of variance with the conditions(five

types tents) and times factors(the first day, the last day).

The Cortisol concentration had main effect on the time factors［F(1，23)＝

45.072 ，ｐ＜0.01］． As we found that the Cortisol concentration had interaction

on environmental

factors significantly ［F(4 ， 20)＝3.017 ，ｐ＜0.05］． As we considered the relation

between the Cortisol concentration and environmental factors.

We conducted the multiple regression analysis between the independent

variable of environmental factors and the dependent variable of the Cortisol

concentration.

Consequently The both of the cubic capacity per person (m

3

/ a person) and

humidity had decreasing with the Cortisol concentration increasing

26

significantly.

The partial correlation coefficient between the Cortisol concentration and the

cubic capacity per person (m

3

/ a person) is significantly negative value 〔Pr＝－

0.83，ｐ＜0.01〕(Table 3).

The partial correlation coefficient between the Cortisol concentration and

humidity is significantly negative value〔Pr＝－0.39，ｐ＜0.01〕(Table 3).

.

The previous papers of the study

8)－10)

were reported that the Cortisol were

called stress hormone by many researcher generally, the Cortisol concentration

had increased with human receiving the stress. Dr Taylor of USA Naval Health

Research Center reported that the Cortisol concentration had increased with time

factors. The much Cortisol concentration increasing with human exposing

the severe stress is much variation of the rising value than the small increasing

value of Cortisol concentration with the calm stress.

Therefore Tents lives of dwellers showed increasing the Cortisol concentration

for ten days of the long terms. We think that the subjects persons remained

chronic stress .

The result of two factors analysis of varaiance showed the interaction

significantly.

And they showed the differences of the Cortisol concentration between the A type

tent and E type tent. The difference of the Cortisol concentration showed the

differences of structures, temperatures, humidity, dwellers persons in the tents.

The result of the multiple regression analysis between the Cortisol concentration

and environmental factors shows significant partial correlation coefficient. The

partial correlation coefficient between the Cortisol concentration and the cubic

capacity per person(m

3

/ a person) is significant negative value〔Pr＝－0.83，

ｐ＜0.01〕(Table 3).

The partial correlation coefficient between the Cortisol concentration and

humidity is significantly negative value〔Pr＝－0.39，ｐ＜0.01〕(Table 3).

The more the cubic capacity per person(m

3

/ a person) was to decrease and the

more the humidity was to decrease, the more the Cortisol concentration was to

increase and to remain high value.

On another expression, as the physiological marker of chronic stress ,the

decreasing the Cortisol concentration needed to increase the cubic capacity

per person and needed to increase the value of humidity. In case of

27

increasing the cubic capacity per person , the dwellers were a few person

and vacant space. The humidity for respiration and perspiration of subjects

are to decrease with increasing cubic capacity per person.

Therefore the independent variable of cubic capacity per person intersected the

independent variable of humidity. The humidity stands on the factor of the cubic

capacity per person. But humidity were received the influence of the

Cortisol concentration with independent physical factor of cubic capacity per

person (m

3

/ a person).

As the temperatures in tents didn’t influence the Cortisol concentration. Generally

they reported that the Cortisol concentration were to increase with cold

temperature.

For instance, Dr Gerra

12)

reported that Cold condition stress were studied two

difference condition rooms between warm surrounding room(25℃ ) and cold

surrounding room(4℃ ).Only the Cortisol concentration with cold temperature

had increased .And the result shows that cold weather condition influences the

Cortisol concentration values .

But On our study , the temperature didn’t influence the Cortisol concentration,

Increasing the Cortisol concentration were influenced by chronic stress without

cold stress.

We add that the environmental factors of humidity is most important factor to

keep comfort amenity in the disaster prevention tents .

Finally increasing humidity of environmental condition in winter season is

important to improve amenity and QOL in the disaster prevention tents.

5. Conclusion

To improve the amenity and QOL in the disaster prevention tents, we elucidated

the relation between the the Cortisol concentration and environmental factors.

Therefore we conducted the two factors analysis of variance with conditions(five

types tents) and times factors(the first day, the last day),the result of two factors

analysis shows main effect on time factors. The last day of the Cortisol

concentration had increased than the first day of it significantly.

Consequently we were confident that dwellers of tents remained chronic stress

with time lapse and tent life fatigue, strain and tiredness. From the result of

multiple regression analysis between the independent variable of environmental

factors and the dependent variable of the Cortisol concentration.

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The Cortisol concentration increased significantly with humidity and cubic

capacity per person(m

3

/ a person) decreasing consequently. Therefore both

humidity and cubic capacity per person are important factors to increase the

Cortisol concentration for improving the amenity and QOL in the disaster

prevention tents.

Especially humidity were to influence the Cortisol concentration without the

relation of cubic capacity per person(m

3

/ a person) . We were confident that

humidity is important environmental factors to improve amenity and QOL in the

disaster prevention tents.

6. Acknowledgments

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Table１ The conditions of using tents

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Table2 The measurement result of environment in tents

Table3 The partial correlation between Cortisol concentration and

environmental facrors（The multiple regression analysis between the Cortisol

concentration and

environmental factors)

(n=50、\*\*：ｐ<0.05、\*\*：

ｐ<0.01)

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Type A 23.8 22.5 71.2 52.5 0.32 0.35

Type B 22.5 17.5 44.4 23.4 0.17 0.19

Type C 20.6 18.3 48.0 46.0 0.07 0.09

Type

D

20.2 19.4 47.6 32.1 0.10 0.13

Type E 11.4 12.2 65.6 42.8 0.15 0.17

outdoor 8.5 4.4 65.0 63.0 0.02 0.02

31

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Multiple

regression

equation

Ｙ(Cortisol)

=16.47－1.03Ｘ(Cubic capacity Per person) －0.04Ｘ(humidity)

（Ｒ

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＝0.69）

Type A、Type B

（ Three Type C tents connect in series make Type A or Type B）

Type C

32

Type D（setting inside curtain）

Type E(setting no inside curtain)

Figure １ the five condition of tents

Mean+S.D..(Each conditions of tents, n=5) \*:p<0.05, \*\*:p<0.01

Figure 2 the Cortisol concentration on each tents for the first day and the

last day

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2

4

6

8

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12

A B C D E

Each tents types

Cortisol concentration（μｇ／ｍｌ）

The first day Cortisol concentration

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The last day Cortisol concentration

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2

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12

A B C D E

Each tents types

Cortisol concentration（μｇ／ｍｌ）

The first day Cortisol concentration

\*\*

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\*

The last day Cortisol concentration

0

2

4

6

8

10

12

A B C D E

Each tents types

Cortisol concentration（μｇ／ｍｌ）

The first day Cortisol concentration

\*\*

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\*

The last day Cortisol concentration

33

LSBE307

Changes of peripheral benzodiazepine receptor gene expression in

major depressive disorder and methamphetamine dependence

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Abstract

Peripheral benzodiazepine receptor (PBR) plays a major role in steroidogenesis. An

alteration of PBR density has been reported in psychiatric disorders. Therefore, the

aim of this study was to investigate the alteration of PBR gene expression in

psychiatric diseases such as major depressive disorder (MDD) and methamphetamine

(METH) dependence. Twenty-two MDD patients (age 41±18 year) and fourteen

METH dependent patients (age 33±7 years) were diagnosed by psychiatrists

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according to Diagnostic and Statistical Manual of Mental Disorders fourth edition

(DSM-IV). Control group for MDD consisted of thirty five positive mental health

subjects (age 32±8 year) and control group for METH dependence consisted of thirty

eight healthy subjects (age 32±5). Blood samples were collected for RNA extraction

and followed by PBR gene amplification using semiquantitative reverse transcriptase

polymerase chain reaction (RT -PCR). Moreover, serum was separated from blood

sample for progesterone determination using electrochemiluminescenceimmuno

assay. A significant decrease in PBR gene expression was found in MDD patients

with suicide attempt when compared with both control group and non-suicide attempt

group. On the other hand, a significant increase in PBR gene expression was found

in METH induced psychosis compared with control group. The results in the present

study suggest that PBR may play a critical role in MDD with suicide attempt as well

as drug dependence and the alteration of PBR expression may be a biological marker

for those diseases. However, the mechanisms of PBR expression in the MDD and

drug dependence are needed to study further.

Keyword: peripheral benzodiazepine receptor, major depressive disorder,

methamphetamine dependence, progesterone

1. Introduction

The peripheral benzodiazepine receptor (PBR) is located in peripheral organs such as

spleen, testis, ovary and adrenal gland and in glial cells in the brain, involved in

steroidogenesis and apoptosis [1]. Although, the functions of PBR within the CNS

are not clear, there have been shown to regulate neurosteroid synthesis, mitochondrial

functions including respiratory chain, ion channel activity, neuroinflammation in

microglial cells and sensitive to endocrine changes and stress [1, 2, 3, 4, 5, 6].

Furthermore, several studies have reported that the density of PBR increases

concomitantly with glial activation following neural injury induced by various insults

such as inflammation, metabolic stress, trauma, transient global forebrain ischemia

and chemically-induced brain injury [3]. An increase of PBR density was also found

in other pathological situations, including sciatic nerve lesion, cerebral infarction,

multiple sclerosis, Alzheimer'sdisease, and astrocytomas [4, 7]. Morover, an

increase of PBR density was observed after exposure to acute stress, but a decrease of

PBR density was found during exposure to chronic stressful condition [2, 8]. PBR, a

biological marker of stress and anxiety, has also been used as a marker of microglia

and astrocyte activation. It has also been described as a pharmacologically specific

marker for neurotoxic amphetamine administration in mice [9, 10]. Therefore, the aim

of this study was to investigate the alteration of PBR gene expression in psychiatric

diseases such as major depressive disorder (MDD) and methamphetamine (METH)

dependence.

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2. Main Body

2.1 Materials and Methods

Subjects

Twenty-two patients (female; n=19, male; n=3, age 41±18 year) meeting DSM-IV

criteria for major depression and 35 healthy subjects (female; n=18, male; n=17, age

32±8 year), free of psychiatric and drug abuse history, were recruited. Fourteen

methamphetamine dependent patients (male, age 33±7 year) were diagnosed by a

psychiatrist according to the DSM-IV and control group consisted of thirty eight

healthy subjects (age 32±5).The experimental protocols were approved by the Human

Ethics Committee of Naresuan University.

PBR and progesterone measurements

Peripheral blood was collected for RNA extraction and followed by PBR gene

amplification using RT -PCR. PCR master mix of each reaction were composed of 1x

Taq polymerase buffer (viviantis, USA), 0.2 mM of dNTPs (invitrogen, USA), 1.25

Units of Taq DNA polymerase (viviantis, USA), 0.2 mM MgCl2

(viviantis, USA),20

µM primers of human PBR (target); F: 5’-AGG GTC TCC GCT GGT ACG CC-3’, R:

5’-TGG GGC AAC CTC TGA AGC TC-3’and β-actin (internal control); F: 5’-CCC

AGA GCA AGA GAG GCA TC-3’, R: 5’-CTC AGG AGG AGC AAT GAT CT -3’ and

4 ng of cDNA sample. The solution was incubated for 2 min at 94°C, followed by

30 cycles of 30 sec at 94°C, 30 sec at 58°C, 30 sec at 72°C with a final 10 min

extension step at 72°C. The PCR products were then analyzed by agarose gel

electrophoresis. PBR genes expression were measured by scion image software and

normalized with house keeping ß-actin gene. Progesterone levels in the serum of all

subjects were measured with Progesterone II kit (cobas, USA) according to

manufacture’s protocol. Differences between groups were analyzed by one-way

analysis of variance (ANOVA).

2.2 Results

The result showed a significant decrease in PBR gene expression in major depressive

patients with suicide attempt when compared with both controls and a non-suicide

attempt group (fig. 1). A significant decrease in serum progesterone concentration

was also observed in major depressive patients (table 1). There was significant

increase in PBR mRNA expression of METH dependent patients (fig. 2). A

significant increased in PBR mRNA expression of METH-induced psychosis (n=11)

was found when compared with control subjects (fig. 3). There was no significant

difference in progesterone level between METH dependent patients and control

subjects (table 2).

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Figure 1 Comparison of PBR mRNA expression between control subjects, non

suicide attempt and suicide attempt patients. Values are mean±SEM. (

\*\*

p = 0.003

compared with control subjects,

##

p = 0.001 compared with non suicide attempt

patients; ANOVA post hoc Bonferroni tests)

Figure 2 Comparison of PBR mRNA expression between METH dependent

patients and control subjects. Values are mean±SEM. (

\*\*\*

p<0.001;

Independent-Samples T Test)

Figure 3 Comparison of PBR mRNA expression between METH-induced psychosis

37

patients and control subjects. Values are mean±SEM. (

\*\*\*

p <0.001;

Independent-Samples T Test)

Table 1. Progesterone serum levels of major depressive patients and controls.

Group

Progesterone levels (ng/ml)

(mean±SD)

Controls (n=15) 2.64±4.56

Major depressive patients (n=15) 0.93±3.03

\*

\* p = 0.049 t test of log-transformed data compared with control subjects.

T able 2. Progesterone serum levels of METH dependent patients and controls.

Group

Progesterone levels (ng/ml)

(mean±SD)

Controls (n=16) 1.07±0.31

Major depressive patients (n=14) 0.98±0.27

2.3 Discussions

PBR gene expression was reduced in MDD with suicide attempt and reductions of

progesterone levels were also observed in MDD. The results indicate that the

attenuation of PBR expression found in suicide attempt may be induced from chronic

stress. The result of low concentration of progesterone level provides an evidence to

support PBR function and contributes a support of neurosteroid deficit in major

depression. Moreover, an up-regulation in PBR mRNA expression was found in

METH dependence. This result provides a strong support of PBR function after

METH induced neurotoxicity in human. An increase of PBR expression may reflect

to the activation of glial cells to protect brain from METH induced neurotoxicity.

The result of progesterone level in METH dependence may be because of an

adaptation of progesterone to normal level after drug withdrawal symptoms.

The results in the present study suggest that PBR may play a critical role in suicide

attempt and drug dependence and the alteration of PBR expression may be a

biological marker for those diseases.

2.4 Acknowledgments

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LSBE262

Leaf Anatomy and Pollen Studies of Zingiberaceae in Lambusango

Wildlife Reserve, Buton Island, Indonesia

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Abstract

The documentation of flora in Sulawesi is far from complete. The general lack

collection is confounded on Zingiberaceae. Besides, the enigmatic of the Amomum

melichroa and Alpinia melichroa from Sulawesi is still under discussion. Studies on

leaf anatomy and pollen have solved many problems in plant taxonomy. In this

research, the characteristics of leaf anatomy and pollen were studied to correct the

taxonomy of plants. The procedure for leaf anatomy analysis was in accordance to the

method suggested by Johansen (1940) modified, whereas the pollen analysis was

performed according to the chlorination method as suggested by Erdman (1952; 1954).

From the study, eight species of ginger collected are found belong to be the family of

Zingiberaceae namely Alpinia galanga, Alpinia melichroa, Alpinia monoplora,

Alpinia sp., Etlingera sp.1, Etlingera sp.2, Amomum testaseum, and Curcuma

domestica. The leaf anatomy such as stomata index, stomata density, and stomata

length are varies between all species. However, pollen unit, shape, and size are

seemed to be uniform in all species. Meanwhile, the combination between pollen

symmetry, structure, exine ornamentation, exine thickness and Aperture appeared to

be different among species and thus can be used as specific characters for the species.

An interesting result was found on pollen of A. melichroa that is different from other

species within the same genus, which prompts question about botanical status of A.

melichroa by Schumann. From the study it is concluded that the leaf anatomy and

pollen data can be used as keys for identification of ginger at species level.

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Keyword: Leaf Anatomy, Pollen, Ginger, Zingiberaceae, Taxonomy

1. Introduction

Sulawesi is one of the islands that are included in the Wallacea Line established

by Alfred Russel Wallace [1]. Wallacea Line was established between Asia Oriental

Region and Australian Region due to the in differences animals and plants from these

reas. Based on these differences, research on plants in this area becomes very

important to be conducted including on Zingiberaceae. Zingiberaceae is one the

largest families in plant kingdom [2] belonging to the Zingiberales order. The family

has about 52 genera and is estimated to contain about 1200-1400 species [3, 4, 5, 6]. It

is documented that Zingiberaceae is distributed in tropical and sub-tropical areas [2],

particularly in Asia from India to New Guinea [7]. Zingiberaceae is herb plant with

leafy shoot, and its entire group has rhizome that grow horizontal in the ground.

Leaves arrangement are distioceus and its sheath formed pseudo-stem. Flowers

arrangement formed a bunch with a bractea that supports one flower. Generally, their

inflorescences are terminal on the leafy shoot and rhizome; and few among of them

have flowers that emerge from the middle of leafy shoot [8].

The exploration of flora in Sulawesi is far from complete [9]. The general lack

collection is confounded on Zingiberaceae [8]. Besides, there has been an on-going

discussion about revision of genus Etlingera in Sulawesi. Moreover, the verification

of the Amomum melichroa and Alpinia melichroa by Schumann also is being finalized

[9]. Studies on leaf anatomy and pollen grain have been used on plant taxonomy

approach for many species and have succeeded to solve many problems in plant

taxonomy that difficult to distinguish with the morphological characteristics.

Generally, the plant taxonomy uses the morphological characteristics to identify

the plant species. However, development of sciences and technologies have increased

the interest of taxonomists to find the other evidences in plant identification such as

plant anatomy, pollen [10] and DNA data. According to Shukula and Misra [11] there

are many anatomical characteristics that can be used to proof the morphological

character in plant taxonomy. These include the size of stomata, shape of stomata, type

of stomata, and index of stomata, type of trichoma, beam transporter arrangement,

papilla, and ergastic substances.

Many researches have been conducted on anatomical studies and have

successfully solved the taxonomy problems, such as Setyawan [12] on Alpinia, Costus

and Hedychium, Nkem et al [13] on two species eggplant and Damayanti [14] on six

species of bananas in Borneo, Indonesia. Besides anatomic character, the pollen

morphology is one of the important data that can be used in plant taxonomy. The

general pollen character that can be used in plant systematic are, pollen size, pollen

shape, pollen type, structure of the pollen wall, pollen architecture, number of

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aperture, aperture position, and aperture shape [15]. Therefore, the objective of this

studied is to examine the leaf anatomy and pollen morphological characters that can

to be used as evidences in plant taxonomy especially in Zingiberaceae.

2. Material and Method

2.1 Sampling Method

Materials of the research were collected from Lambusango Wildlife Reserve, Buton

Island, Indonesia. Sampling area was located in Kakenauwe, Kaweli, Wagari and

Wakangka Vilages. Samples were collected between July to September 2010 by

exploration method. The flowering and fruiting Zingiberaceae plant were collected as

samples. The anthers for each plant were collected from the flowers and kept in the

bottle with glacial acid for pollen characterization in the Laboratory. The leaf for

anatomical characterization was collected from the third leaf to the youngest for every

leafy shoots. The leaf samples were collected in 3 replicates for all species from

different leafy shoot, and then were preserved in the bottles with 70 % alcohol.

2.2 Leaf Anatomical Characterization

The slide preparation for leaves anatomic study was in accordance to the method

suggested by Johansen [16] modified. The slide was observed by Nikon Eclipse

Microscope with Nis Element Imaging Software (NEIS). Analysis of different

characters of each sample was done with three repetitions. The repetition of slide was

taken from different leaf that was collected from other leafy shoot from the same

species. Every character such as the length of stomata was measured as many as ten

replications and the mean value was recorded. This step was repeated on different

slide from different leaf as replication as many as three times for all abaxial and

adaxial epidermis of all samples. The epidermis for each slide was observed under the

microscope beginning from low magnification (100X) to medium magnification

(400X) to identify the general character and then high magnification (1000X) was

used to measure the length of the stomata.

2.3 Pollen Characterization

The slide preparation for pollen characterization was done by chlorination method as

suggested by Erdman [15]. Identification of pollen characters was observed by Nikon

Eclipse Microscope (NEIS). The characters of pollen for every species were done by

three repetitions on different slide. In each repetition as many as 30 pollens wer e

measured to ensure the accuracy of characters that were identified. Similarly

observations of pollens under the microscope were conducted with low magnification

(40X) for general characters, followed as high magnification (1000X) for specific

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characters. On high magnification, oil immersion was applied to enhance the focus to

the objects identified.

3. Results and Discussion

3.1 Results

From the observation, all type of stomata for both leaves surfaces are identified as

Paracytic, in which one or more of the subsidiary cells that flank the stoma are

parallel with the long axis of the guard cells. As can be seen (Table 1 and Figs 1-8) the

shape of cell epidermis is dominantly elongated-hexagonal for both adaxial and

abaxial epidermis, except A. galanga and C. domestica is polygonal on adaxial suface.

The stomata index for all species is different for every leaf sample in each species.

The greatest stomata index value for adaxial epidermis was found in Etlingera sp.1

(1.636), and the lowest in A. Monoplora (0.149). For the abaxial epidermis greatest

was found in Etlingera sp.1 (8.58), and the lowest in C. domestica (4.213). The

highest density of stomata on adaxial epidermis is Alpinia sp (102.74), and the lowest

is Etlingera sp.2 (7.52), whereas the highest density of stomata for abaxial epidermis

is Etlingera sp.1 (862.1), and the lowest is C. domestica (80.98). The result from the

observation the length of stomata found that the largest stomata for adaxial epidermis

is C. domestica (30. 24) and smallest is A. monoplora (17.14), whereas the largest for

the abaxial epidermis is C. domestica (33.04) and the smallest is Etlingera sp.1 (13.6).

Trichomes on leaves surface in this study was only found as adaxial type in species A.

monoplora.

The results from the measurement of the pollen grain showed that all pollen units

are monad with shape for Index (P/E) is prolate spheroidal (Table 2 and Figs 9-16).

There was a variation in the size of pollen grain for all species; for instance Etlingera

sp.1, its pollen size is in medium category (46 µ) and for Etlingera sp.2 in big

category (56 µ), while the others are in a very big category (>100 µ). The types of

pollen symmetry are generally radial in five species i.e, (A. melichroa, Alpinia sp,

Etlingera sp.1, Etlingera sp.2 and C. domestica), while three other species i.e, (A.

galanga, A. monoplora, and A. testaceum) are bilateral. All pollen structures are

tectate with the ektexine is psilate except for A. melichroa which is intectate; where it

has spine on its ektexine with length size of (4.5µ).

Five samples have been found to have endexine which include Verrucate (A.

melichroa, A. galanga, Etlingera sp.1, Etlingera sp.2 and A. testaceum), whereas

three other samples are reticulate i.e, (A. melichroa, Alpinia sp, and C. domestica).

The thickness of ektexine and endexine are varies for all species sample, the thickest

of ektexine is A. melichroa (23.98 µ) and endexine is A. monoplora (5.4 µ), while the

thinnest of ektexine is A. melichroa (5.22 µ) and endexine is Etlingera sp.1 (1.1 µ).

There are two from eight samples that have aperture namely A. galanga with polypore

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aperture type (7 aperture), and A. monoplora with polypore aperture type also (5

aperture), while the other are none aperture pollen. The data observation of leaf

anatomy and pollen morphology of Zingiberaceae in Lambusango Wildlife Reserve,

Buton Island, Indonesia was compiled in the Table 1 and Table 2 below.

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Table 1 Comparison of the leaves anatomical character of Zingiberaceae in Labundobundo Wildlife Reserve Buton Island, Southeast Sulawesi, Indonesia

No Species Epidermis

Type of

Stomata

Shape of epidermis

cell

Stomata Area

Index (mm

-1

)

density of Stomata (mm

-2

) Length of stomata (µm) Trichoma

Repetition

Average

Repetition

Average

Type of

Cell

Size

(µm)

1 2 3 1 2 3

1 A. melichroa

AD Paracytic Elongated-hexagonal 0.558 20.08 17.85 20.08 19.34 23.478 24.009 23.717 23.73 - -AB Paracytic Elongated-hexagonal 6.273 133.92 109.37 120,53 121.27 21.417 20.147 18.494 20.01 - -2 A. galanga

AD Paracytic Polygonal 1.199 39.51 37.5 30 35.61 21.3 21.971 22.507 21.92 - -AB Paracytic Elongated-hexagonal 7.898 355.97 356.77 353.36 355.37 18.774 19.384 19.846 19.33 - -3 A. monoplora

AD Paracytic Elongated-hexagonal 0.149 8.92 12.01 12.01 10.98 17.356 17.057 17.035 17.14 - -AB Paracytic Elongated-hexagonal 6.631 200 208.33 210.67 206.33 15.982 16.737 15.959 16.22 unicellular 155.82

4 Alpinia sp

AD Paracytic Elongated-hexagonal 0.172 89.28 110.29 108.69 102.75 20.394 17.943 18.493 18.94 - -AB Paracytic Elongated-hexagonal 8.8 468.75 517.24 666.67 550.88 15.323 16.985 16.394 16.23 - -5 Etlingera sp.1

AD Paracytic Elongated-hexagonal 1.636 45.18 45.28 53.57 48.01 19.102 19.327 18.759 19.06 - -AB Paracytic Elongated-hexagonal 8.958 885.41 875 825.89 862.10 13.318 13.477 14.026 13.60 - -6 Etlingera sp.2

AD Paracytic Elongated-hexagonal 0.247 6.94 8.92 6.69 7.52 22.053 23.682 22.659 22.79 - -AB Paracytic Elongated-hexagonal 6.978 337.5 331.63 291.67 320.26 18.907 17.551 18.485 18.31 - -7 A. testaseum

AD Paracytic Elongated-hexagonal 0.358 13.58 7.81 11.90 11.10 24.115 21.797 21.858 22.59 - -AB Paracytic Elongated-hexagonal 6.757 172.79 167.61 163.46 176.95 22.485 23.703 22.979 23.05 - -8 C. domestica

AD Paracytic Rhomboid, hexagonal

to polygonal

1.452 15.62 17.85 8.92 14.13 29.031 31.256 30.458 30.24 - -AB Paracytic Elongated-hexagonal 4.213 73.86 71.42 97.65 80.98 32.493 35.7 31.266 33.04 - -Table 2 Comparison of the pollen characteristic of Zingiberaceae in Labundobundo Wildlife Reserve Buton Island, Southeast Sulawesi, Indonesia.

No Species

Indicator

Pollen

Unit

Shape of pollen

(P/E)

Size of Pollen

(μm)

Symmetry

of pollen

Structure

of Pollen

Exine Ornamentation Exine thickness Aperture

Ektexine

Length

of

spine

Endexine Ektexine Endexine Shape No. Type

1 A. melichroa Monad Prolate spheroidal (118) Very big Radial Intectate Echinate 4.50 Verrucate 23.98 3.77 - - None aperture

2 A. galanga Monad Prolate spheroidal (148) Very big Bilateral Tectate Psilate - Verrucate 7.72 2.71 Porat 7 Polypore

3 A. monoplora Monad Prolate spheroidal (160) Very big Bilateral Tectate Psilate - Reticulate 14.41 5.40 Porat 5 Polypore

4 Alpinia sp Monad Prolate spheroidal (116) Very big Radial Tectate Psilate - Reticulate 13.67 3.46 - - None aperture

5 Etlingera sp.1 Monad Prolate spheroidal (46) medium Radial Tectate Psilate - Verrucate 5.22 1.10 - - None aperture

6 Etlingera sp.2 Monad Prolate spheroidal (56) Big Radial Tectate Psilate - Verrucate 6.53 1.19 - - None aperture

7 A. testaseum Monad Prolate spheroidal (131) Very big Radial Tectate Psilate - Verrucate 21.76 3.54 - - None aperture

8 C. domestica Monad Prolate spheroidal (130) Very big Bilateral Tectate Psilate - Reticulate 17.60 1.95 - - None aperture

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Figs. 1-8. The stomata

micrographs of

Zingiberaceae species in

Lambusango Wildlife

Reserve, Buton Island,

Indonesia. (1) A. melichroa

(2) A. galanga (3) A.

monoplora (4) Alpinia sp (5)

Etlingera sp.1 (6) Etlingera

sp.2 (7) A. testaceum (8) C.

domestica. Magnification =

400X

Figs. 9-16. The pollen

micrographs of

Zingiberaceae species in

Lambusango Wildlife

Reserve, Buton Island,

Indonesia. (1) A.

melichroa (2) A. galanga

(3) A. monoplora (4)

Alpinia sp (5) Etlingera

sp.1 (6) Etlingera sp.2 (7)

A. testaceum (8) C.

domestica. Magnification

= 400X

3.2 Discussion

According to Rarford [10] and [17], stomata type on leaf is one of the characters

that can be used in plant classification. The result of this study was found that all

stomata type is paracytic (Figs 1-8). The same results have been found from the study

of six of bananas in west Kalimantan by Damayanti [14]. The shape of epidermis cells

is uniform for all species except A. galanga, in which its adaxial epidermis cell is

polygonal, and C. domestica is rhomboid, hexagonal to polygonal, and these

characters only can be used as character for family as well as for order levels. Based

on the results from the observation, the characters that can be used to identify

Zingiberaceae are the stomata index, stomata density, stomata length and trichoma.

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The results have been supported by Rarford [10], that these characters are useful to be

used to distinguish the plant taxon in species level.

The same results as reported by Damayanti [14]; where these characters were

also used to distinguish six species of bananas, and Nkem et al [13], who used this

data to distinguish eggplant species in Nigerian. Data of pollen symmetry, pollen

structure, exine ornamentation (ektexine and endexine), exine thickness and pollen

aperture can be used to distinguish the species in the same genus. Consideration of

those characters as pollen characters to distinguish the species was supported by

Erdtaman [15] and Radford [10]; in which, all of these characters can be used to

identify the plant taxon at family, genus, and species levels.

An interest on result pollen characterization was found on A. melichroa; in concept

of its pollen which is different as compared to the other three species in the same

genus (Table 2). Three species from genus Alpinia have ornamentation psilate on its

ektexine, except A. melichroa has ornamentation echinate; in which the length of its

spine was measured about 4.5 µm. If the ektexine structure can be considered for

specific character for genus level on Alpinia as well as on species, this data may raise

up questions about A. melichroa K. Schum. in which the status still under discussion

until now. In the first time, A. melichroa and A. chrynogynia were described by K. M.

Schumann (1904) to maintain Amomum in Vietnamese. In (1990) R. M. Smith

excluded A. melichroa and A. chrynogynia, from genus Alpinia and suggesting that

they might better placed in Amomum (9). The latest study of Zingiberaceae in

Sulawesi was conducted by A. D. Poulsen (2008-2009), and declared that A.

chrynogynia K. Schum is a species of Etlingera. However, A. melichroa K. Schum

still not clear in his manuscript (9), and consider it as the species that is not reported

until now.

4. Conclusion

Eight species of Zingiberaceae were collected namely: A. melichroa, A. galanga, A.

monoplora, Alpinia sp, Etlingera sp.1, Etlingera sp.2, A. testaceum, and C. domestica.

All stomata index, stomata density, and length of stomata are varies for all species,

and trichoma on the leaf was only found in A. monoplora. The pollen characters such

as pollen unit, shape, and size seemed to be uniform for all species. Meanwhile, the

combination between pollen symmetry, structure, exine ornamentation, exine

thickness and Aperture appeared to be different among species and thus can be used

as specific characters of species. An interesting result was found in the pollen of A.

melichroa which was different from other species in the same genus, which prompts

to a question about botanical status of A. melichroa by Schumann. We conclude that

the leaf anatomy and pollen data can be used as a key for identification of

Zingiberaceae in species level.

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of Lambusango Wildlife Reserve for their guidance during the exploration and

collection of samples,

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Civil Engineering I

2013/3/16 Saturday 09:00-10:30 Room 604

Session Chair: Prof. Mohammed Enamul Haque

ACCMES 113

Multilayer Perceptron Back-Propagation Artificial Neural Network Model to

Predict Failure Loads on Reinforced Concrete Slabs

Mohammed Enamul Haque︱Texas A&M University

ACCMES 63

Factors Affect the Strength Development of Repaired Pavement Using Recycling

Technique

Avirut Chinkulkijniwat︱Suranaree University of Technology

ACCMES 96

Numerical Analysis to Better Understand the Failure Mechanism and

Reinforcements on the Tunnel Face of an Earth Pressure Balance Shield - A

Case Study of Mashhad Metro Line 2

Saba Gharedashi︱Amir Kabir University of Technology

Milad Barzegar︱Amir Kabir University of Technology

ACCMES 109

Simulations of Control Characteristics of Tuned Liquid Column Damper Using

an Elliptical Flow Path Estimation Method

Passagorn Chaiviriyawong︱Prince of Songkla University

Suchart Limkatanyu︱Prince of Songkla University

ACCMES 148

Response Analysis of Strike-Slip Fault Movement on Buried Pipeline

Md Aftabur Rahman︱Saitama University

Hisashi Taniyama︱Saitama University

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ACCMES 153

Optimum Cross-Sectional Floating Structure

Du Ho Lee︱Korea Institute of Construction Technology

Youn Ju Jeong︱Korea Institute of Construction Technology

Young Jun You︱Korea Institute of Construction Technology

Min Su Park︱Korea Institute of Construction Technology

ACCMES 155

Hydraulic Conductivity of Various Shapes of Sands

Nurullah Akbulut︱Hasan Kalyoncu University

Ali Firat Cabalar︱University of Gaziantep

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ACCMES 113

Multilayer Perceptron Back-Propagation Artificial Neural Network

Model to Predict Failure Loads on Reinforced Concrete Slabs

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Abstract

In order to minimize the extensive calculations required to predict the failure loads of

reinforced concrete slabs, this paper describes an artificial neural network (ANN)

based training model to predict failure loads. To create training and model validation

data, several square/rectangular slabs with varying edge support conditions, slab

thicknesses, and reinforcements were analyzed to determine failure loads using a

virtual work method for yield-lines failure mechanism. When a slab fails in flexure,

the rebar yields first in the region of highest moment, and this portion of slab acts as a

plastic hinge. With additional loads, the hinging region will rotate plastically, and

moments will be redistributed to neighboring regions, causing them to yield as well.

Eventually, enough yield lines will be developed to cause the slab to deformed

plastically and collapse without any additional loads. The ANN model was

developed with NeuroShell-2 software using a multilayer perceptron (MLP)

back-propagation (BP) architecture. The ANN model was trained with a set of 450

concrete slab analysis data, and the trained model was validated using a new set of 54

slabs analysis data. The ANN predicted values of slab failure loads were found to

demonstrate very good agreement with the calculated values.

Keyword: Artificial Neural Network, yield-line analysis, reinforced concrete slab,

failure load.

1. Introduction

The yield line analysis of reinforced concrete slab uses rigid plastic theory to compute

the failure loads corresponding to plastic moment resistances in various parts of the

slab. The concept of yield line analysis was first proposed by A. Ingerslev in

1921-1923, and it was subsequently extended to modern yield line theory by K.W.

Johansen [1]. When the yield line pattern is formed in regions of maximum moment,

it divides the slab into a series of elastic plate segments. Once the yield lines have

formed, all further deflections due to additional loads are concentrated along the yield

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lines, and the slab deflects as a series of rigid plates connected together by long hinges

along the yield lines (Figure 1). The external work done by the loads to cause a

small arbitrary virtual deflection (δ) must equal the internal work done as the slab

rotates at the yield lines to accommodate this deflection. In the virtual work method of

analysis, by giving a virtual displacement to slab the rotations at various yield lines

can be calculated. By equating the internal and external work, the relationship

between the ultimate loads and the resisting moments of the slab can be obtained.

The elastic rotations and deflections are not considered in the work calculation since

their values are negligible compared to plastic rotation and deflection. There are

several textbooks available where virtual work method of analysis has been discussed

in details [2, 3].

Figure 1. Plastic Mechanism for a rectangular slab with moment resistant edges

The objective of this paper was to develop an artificial neural network (ANN) based

trained model to predict failure loads on two-way rectangular reinforced concrete slab.

In order to create training data, several square/rectangular slabs with different edge

support conditions, slab thickness, and slab reinforcements (positive and negative)

were analyzed to determine failure loads using a virtual work method for yield-lines

failure mechanism.

ANN is one of the artificial intelligence algorithms that relates to the class of machine

learning. It mimics the natural human brain’s process of acquiring and retrieving

knowledge. It models the biological neuron, which consists of nodes (cells) and links

(axon). It is defined as a computing system made up of a number of simple, highly

interconnected processing elements, which process information through their dynamic

state responses to external input [4]. Each processing element (PE) or artificial neuron

has an input and an output side. The connections are on the input side correspond to

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the dendrites of the biological original and provide the input from other PEs while the

connections on the output side correspond to the axon and transmit the output.

Network training is an act of continuously adjusting their connection weights until

they reach unique values that allow the network to produce outputs that are close

enough to the desired outputs. The learning ability of a neural network is determined

by its architecture and by the algorithmic method chosen for training. Currently,

back-propagation is the most popular, effective, and easy to learn model for complex

networks [5, 6]. Figure 2 depicts a schematic representation of an ANN with multiple

layers or slabs, i.e. a MLP. The BP training algorithm consists of two main steps, a

forward step which involves generating a solution to the classification problem in

question, and then a back propagation of the error to modify the weights in the

direction of minimum error. The forward step presents the inputs as training examples

to the ANN, which is passed to each hidden node in the hidden layer where the

activation at that node is calculated using a sigmoidal transfer function [7] in order to

yield an output which is transferred to the output layer. In the back-propagation step,

the difference in error between the ANN output and the target output is calculated and

used to adjust the values of the connecting weights, from the output, through the

hidden layer, to the input layer [8]. These steps are repeated until a minimum error

between the ANN predicted output and the target output value is reached.

Figure 2. Schematic Representation of MLP

2. ANN Model Development Methodology

A set of 450 rectangular and square reinforced concrete slabs analysis data for

training of an ANN model was created b y manually performing virtual work method

of analysis. In addition, another set of 54 slabs data was created manually in order to

validate the trained ANN model. Using several sets of slab thickness, concrete

strength (f

c

’), reinforcing steel yield strength (f

y

), rebar size and spacing were

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considered to calculate various sets of moment strength per unit width of slab (Figure

3).

Figure 3. (a) Top reinforcement, Negative Nominal Moment Capacities, Mnnx, M

nny;

(b) Bottom reinforcement, Positive Nominal Moment Capacities, Mnpx, M

npy

Depending on the aspect ratio of the rectangular panel and moment strengths, there

are three possible yield line patterns can be formed (Figure 4). For a given set of data,

slab length (L), width (W), thickness (h), nominal moment strengths (M

npx, M

nnx, M

npy

,

Mnny

), and by iteratively changing the value of  (0<0.5) or solving for  by means

of differential calculus the failure load (q

f

) was calculated by equating the external

and internal work done. The value of factored load, q

u

was calculated by multiplying

qf with reduction factor,  (where  =0.9). The training data included six inputs – L,

W, Mnpx, M

npy, M

nnx, and M

nny

, one output – q

u

.

Figure 4. Three possible yield line patterns

The ANN model was developed with NeuroShell-2 software using a multilayer

perceptron (MLP) back-propagation (BP) architecture [9]. The Ward network

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architecture is shown in Figure 5. A total of five layers of neurons with one input

layer, three hidden layers, and one output layer were used. Different activation

functions were applied to hidden layer slabs that led to a better prediction. Activation

functions - Logistic, Gaussian, symmetric-logistic, Gaussian-complement, and

Logistic were used in Slabs 1 through 5 respectively. The hidden neurons: 6, 8, 8, 8, 1

were used in Slabs 1 through 5 respectively. For the BP training criteria, “Rotation”

was used for pattern selection, which selects training patterns in the order they appear

in the input file, and “TurboProp” was selected for weight updates. “TurboProp” is

simpler to use than the other methods because the user does not have to set learning

rate and momentum. The training criteria also included fixing the maximum and

minimum absolute errors, minimum average error, and the number of learning epochs

since minimum average error. When the given training criteria were met, training of

the model was stopped.

Figure 5. Architecture of MLP BP Ward Neural Networks [9]

3. Results and Discussion

The training data set of 450 reinforced concrete slabs was randomly divided into two

sets: (1) 80% data for training the network, and (2) 20% data for testing the network

during training, and continuously correct the training by adjusting the weights of the

network links. Figure 6 demonstrates the scattered plot of ANN predicted q

u

and

calculated q

u

during the training phase of the model. Another set of 54 reinforced

concrete slab data was used for validate the trained model. This validation set data

was not used during training. For validation, this set of data was presented to the

trained model to predict the output. Figure 7 demonstrates the scattered plot of the

predicted and calculated q

u

values during validation phase. Both of these figures

clearly demonstrate a very good agreement between the calculated values of q

u

and

ANN predicted qu

.

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Figure 6. Scatter plot of ANN predicted vs. calculated qu

(kPa) – Training Phase

Figure 7. Scatter plot of ANN predicted vs. calculated qu

(kPa) - Trained model

validation phase.

The neural network used for the presented model demonstrated an excellent statistical

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performance as shown in Table 1 for the training model and the validation of the

trained model. In Table 1, R squared is a statistical indicator usually applied to

multiple regression analysis. It compares the accuracy of the model to the accuracy of

a trivial benchmark model wherein the prediction is just the mean of all of the

samples. A perfect fit would result in an R squared value of 1, a very good fit near 1,

and a very poor fit near 0. The correlation coefficient, r is a statistical measure of the

strength of the relationship between the actual vs. predicted outputs. The r

coefficient can range from -1 to +1. It will show a stronger positive linear relationship

when r is closer to +1, and a stronger negative linear relationship when r is closer to

-1. Table 2 illustrates a set of rectangular slabs that are analyzed for failure loads

using yield line theory, and compared with the ANN model predicted values. It

shows that the ANN predicted values are in very good agreement with the calculated

values.

Table 1. Network system performances

Table 2. Calculated and ANN Predicted qu

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4. Conclusions

It is demonstrated in this paper that the Artificial Neural Network (ANN) based

trained model can be applied to determine failure loads for reinforced concrete slabs.

An ANN model was developed with NeuroShell-2 software using a multilayer

perceptron (MLP) back-propagation (BP) architecture. Several square/rectangular

slabs with different edge support conditions, slab thickness, and slab reinforcements

(positive and negative) were analyzed for failure loads using a virtual work method of

yield-lines failure mechanism, and the analyzed data set was used to train the ANN

model. The trained model was then validated using a new set of data that unused

during training, and compared with the calculated values. The ANN model

demonstrated an excellent statistical performance in the network training as well as in

the validation of the trained network. The ANN predicted values were found to

demonstrate very good agreement with the calculated values. The application of an

ANN model in similar real-world applications will certainly minimize the need for

extensive manual calculations.

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ACCMES 63

Factors Affect Strength of Repaired Pavement Using the Recycling

Technique

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Abstract

The pavement recycling technique is a way to effectively repair damaged pavements.

In this study, statistical analysis shows that the field strength is significantly lower

than the laboratory strength. The mixing process used in the pavement recycling

technique does not significantly affect the field strength reduction as indicated by the

small variation of the field hand-compacted strength (

ufh

q

) and the laboratory strength

(

ul

q

). The curing condition does significantly control the field strength development.

A factor of safety of 2.0 is recommended for design.

1. INTRODUCTION

The pavement recycling technique is widely used in various countries,

including Thailand, to restore damaged pavements. However, the field strength

development is generally found to be lower than the laboratory strength (e.g.,

Horpibulsuk et al., 2004; Horpibulsuk et al., 2006; Horpibulsuk et al., 2011a).

Understanding the mechanism that controls the field strength development is vital to

improve the mixing process and field quality controls to obtain the strongest recycled

pavement at a low construction cost. Also, this understanding helps determine the

appropriate factor of safety, which is the ratio of the field strength to laboratory

strength. The difference between laboratory and field strength is possibly due to the

non-uniformity in mixing in-situ soil with cement and differences in the compaction

method and curing condition (Horpibulsuk et al., 2006). The objective of this paper is

to statistically analyze the field strength data to understand the mechanism controlling

the field strength development and thus suggest the best practice for pavement

recycling in Thailand. This study is fundamental, and the results could possibly be

applied in other tropical countries.

By default, a significance level (p-value) of 0.05 was used throughout this

study. If the significance level in the test output is less than 0.05, the assumption of

equality of the two strength data sets (null hypothesis) is not valid with a probability

of 95%. However, if the significance level is greater than 0.05, then with a probability

of 95%, the two strength data sets are similar.

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2. MATERIALS AND METHODS

2.1 Laboratory Investigation

Two different soils, which represent typical coarse-grained materials often

used in earth work, were used in this laboratory study: lateritic soil and crushed rock.

The lateritic soil was taken from a borrow pit in the Nakhon-Ratchasima Province,

Thailand. The lateritic soil was composed of 28.5% fine-grained particles and 71.5%

coarse-grained particles and was non-plastic with a liquid limit of 22.5%. The crushed

rock was taken from a quarry in the Phetchabun Province, Thailand. The crushed rock

was composed of 91% coarse-grained particles and the rest were fine-grained

particles. Based on the Unified Soil Classification System, the lateritic soil and

crushed rock were classified as silty sand (SM) and well-graded silty gravel

(GW -GM), respectively. Several basic properties of these soils are presented in Table

1.

Table1. Basic properties of soils used for establishing and verifying the model

Soil LL PI

Group

Symbol

Source

Soils used for establishing the model

Lateritic

soil

22.5 NP SM Horpibusuk et al. (2006)

Crushed

rock

GW-GM Horpibusuk et al. (2006)

Soils used for verifying the

model

Lateritic

soil

36 20 GC Ruenkrairergsa and Charatkorn

(2001)

Lateritic

soil

NP NP SW -SM Sirilertwattana (2006)

Lateritic

soil

21.5 6.8 GW-GM Sirilertwattana (2006)

Both soils were passed through a 19-mm sieve to remove coarser particles. The

water content of the soils was adjusted to 0.6, 0.8, 1.0, 1.2 and 1.4 times the OWC.

The soils at their respective water contents were thoroughly mixed with Type I

Portland cement at cement contents varying from 1 to 7%. The soil cement mixture

was compacted according to ASTM D696-91 in a standard 100-mm diameter mold

under four compaction energy levels (296.3, 592.5, 1346.6 and 2693.3 kJ/m

3

). After

24 hours, the samples were dismantled, wrapped in vinyl bags and stored in a

humidity chamber at a constant temperature (25±2

o

C). Unconfined compression tests

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were run after the samples cured for 7, 14, 28, 60 and 120 days. For each curing time

and each combination of water content and cement content, at least 3 samples were

tested under the same condition to check for consistency. The strength of these

samples will be referred to as the laboratory strength (

ul

q

).

2.2 Field Investigation

The field strength data of the stabilized pavement materials were gathered from 4

roadway sites (3 sites in the Phetchabun Province and 1 site in the Utaradit Province)

using the pavement recycling technique. The input cement for each site was obtained

from trial modified Proctor tests at the OWC to attain 7-day strengths of 2750 kPa for

Phetchabun 1, Phetchabun 3 and Utaradit, and 3500 kPa for Phetchabun 2. Damaged

pavement at a thickness of approximately 20 cm was dug up and mixed with the

cement and water by the recycling machine. At each station, which were 150 meters

apart, the soil-cement mixture was collected from the machine and manually

compacted in the laboratory. These samples are herein referred to as the “field

hand-compacted samples”.

Immediately after mixing, the soil-cement mixture was field compacted by a

vibratory roller, going back and forth for 3 passes and followed by a pneumatic roller

for 5 passes and a smooth wheel roller for 3 passes. The frequency of the vibratory

roller was 1500 cycles per minute. The pneumatic roller consisted of 6 rubber tires

with a contact pressure under the tires of approximately 600 kPa. The smooth wheel

roller used 2 smooth metal rollers with a ground contact pressure of approximately

350 kPa. This field compaction results in a ratio of the dry unit weight (

dfh dfr

  /

) at

each station greater than 95%, where

dfr



is the dry unit weight of the field-mixed

and roller-compacted samples, which was obtained from a sand cone test within 1

hour after field compaction. The

dfh



is the dry unit weight of the field

hand-compacted sample at each station. A high

dfh dfr

  /

value indicates high field

quality controls. For each station, the field-mixed and roller-compacted samples were

taken by a coring cutter from the improved pavement after 7, 14 and 28 days of curing

to conduct the unconfined compression test. These samples were trimmed to a

diameter to height ratio of 1.0, matching those prepared in the laboratory. These

samples are herein referred to as the “field roller-compacted samples”. Because the

samples are hard, carefully cored and trimmed, the effect of the sample disturbance on

the strength can be neglected.

3. ANALYSIS OF THE FIELD STRENGTH DEVELOPMENT

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The unconfined compressive strengths from the three different cement-stabilized

sample sets, the field hand-compacted strength (

ufh

q

), the field roller-compacted

strength (

ufr

q

) and the laboratory strength (

ul

q

) were statistically analyzed to evaluate

the mechanism influencing the field strength development. The SPSS software was

used for this objective. The variation of these three strengths at the different test sites

is illustrated in Fig. 1. By setting

ul

q

as a reference, the difference between

ufh

q

and

ul

q

is likely attributed to the non-uniformity in the mixing cement with the dug

pavement materials in the mixing machine, whereas the difference between

ufr

q

and

ufh

q

is due to the differences in the compaction and curing methods. The dashed line

represents the laboratory design strength (

ul

q

).

A t-test was performed to compare the mean values of

ufh

q

and

ufr

q

(Table

2). The results indicate that the variances between

ufh

q

and

ufr

q

are homogeneous at

a significance level of 0.123 based on Levene’s test. Thus, a t-value with equal

variance was used. A significance level of 0.000 was found for the 2-tailed test, which

indicates that the strength of the field hand-compacted samples (mean value =

2872.43 kPa) had a significantly higher strength than that of the field

roller-compacted samples (mean value = 2243.22 kPa).

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Fig.1. Field roller-compacted and field hand-compacted strength after 7 days of curing

Table2. Independent samples test to compare means of the

ufh

q

and

ufr

q

Levene’s test for

equality of

variances

t-test for equality of means

F Sig. t df

Sig. (2 tailed)

Mean

difference

Std. error

difference

Equal variances assumed 2.404 .123 7.952 154 .000 629.212 79.122

Equal variances not assumed 7.925 147.437 .000 629.212 79.122

The variation of

ufh

q

compared with

ul

q

for each site was studied. The t-test

result (Table 3) shows that the significance (2-tailed) levels are greater than 0.05 at

most of the sites, i.e., Phetchabun 1, Phetchabun 2 and Utaradit, which indicates the

equality between

ul

q

and

ufh

q

at most of the sites. Only one site from the four

studied sites showed that

ul

q

and

ufh

q

were not equal at a probability of 95%.

It is a well-known fact that mixing results in relative movement among the

components in the mixture and thereby affects the strength and deformation properties

of the stabilized soil (e.g., Hayashi and Nishikawa, 1999; Larsson et al., 1999). From

the equality between

ul

q

and

ufh

q

, it can be concluded that the in-situ mixing by the

machine is generally uniform and acceptable. Therefore, it can be assumed that the

mixing process does not significantly affect the field strength reduction when the

pavement recycling technique is used. This conclusion contradicts the results in the

case of deep-mixed columns (Horpibulsuk et al., 2004; Horpibulsuk et al., 2011b,

Larsson et al., 2005) In fact, uniformity of deep mixing is rarely achieved due to the

viscosity of the clay and the very high in-situ effective overburden stress. The flow

ability of the cement admixed coarse-grained soil is much higher than that of

fine-grained soil. Therefore, the shallow stabilization of the coarse-grained soil is

more uniform.

Table 3. Equality test between

ul

q

and

ufh

q

at each studied site

Sites N Mean Std. deviation Test value

(

ul

q

)

t df Sig.

(2-tailed)

64

(

ufh

q

)

Phetchabun1 33 3834.170 332.629 2750 1.454 32 0.156

Phetchabun2 18 3294.484 431.120 3500 -2.023 17 0.059

Phetchabun3 19 2498.558 310.580 2750 -3.634 18 0.002

Utaradit 8 2968.750 270.420 2750 2.288 7 0.056

The large difference between

ufh

q

and

ufr

q

(Table 3) indicates that the

compaction and curing conditions greatly affects the field strength development. In

terms of the compaction condition, the compaction method and the compaction effort

might affect the field strength. However, the compaction was performed by vibratory

and pneumatic rollers, which is a widely used method for highway and pavement

works. These rollers are known to be effective in compacting granular material and

are generally used in field compaction processes. Moreover, the compaction was well

controlled as indicated by the very high relative densities, over 95%. Hence, the

compaction condition should not be a concern. Thus, the curing condition is the only

major factor that should be taken into account.

Field curing is performed by spraying water on the recycled pavement a

couple of times a day without covering the remedied pavement with saturated cover

material, such as burlap or rugs, or adding a curing compound. Unless the concrete

were to attain a greater field strength, this practice seems inadequate, particularly in a

hot country such as Thailand.

To determine the influence of the curing method, the difference between the

laboratory and field strengths was investigated using

ufr

q

to

ul

q

ratios. The

distribution of the strength ratios at the test sites is illustrated in Fig. 2. The

descriptive statistics for

ul ufr

q q /

ratios are presented in Table 4. The 95

th

percentile

was 1.05, indicating that the magnitude of

ufr

q

was less than the magnitude of

ul

q

for most of the populations. The 5

th

percentile was 0.52, meaning that 95% of the

population had a magnitude of

ufr

q

greater than

ul

q 52 . 0

; in other words, the field

strength was almost half the laboratory strength.

In the mix design process, many laboratory trial mixes are performed to

acquire the laboratory strength so that the field strength reduction can be compensated.

For the current practice in Thailand, a safety factor of 2.0 is suggested. In addition, it

is recommended to cure

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4. CONCLUSIONS

The laboratory and field strength development of cement-stabilized coarse-grained

soils when the pavement recycling technique is used was statistically analyzed. The

field strength was significantly lower than the laboratory strength. A ratio between the

field and laboratory strengths was normally distributed. The field strength reduction

was mainly caused by the insignificant amount of curing water due to the hot weather

in Thailand. With this curing condition, the 5

th

percentile of the field to laboratory

strength ratio was 0.52. Hence, it is logical to assign a factor of safety of 2.0 when

determining the input of cement.

Fig.2. Distribution of the strength ratio,

ul ufr

q q /

Table 4. Descriptive statistics for

ul ufr

q q /

Statistics Values

N 78

Mean .7640

Std. Deviation .1599

Kolmogorov-Smirnov Z .805

Asymp. Sig. (2-tailed) .536

5

th

Percentile 0.5194

95

th

percentile 1.0547

66

5. acknowledgement

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Numerical analysis to better understand the failure mechanism and

reinforcements on the tunnel face of an Earth Pressure Balance

shield - A case study of Mashhad metro line 2

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Abstract

In order to understand the mechanism of the effects of varying face support pressures

on tunnel stability, numerical simulations are conducted using the three-dimensional

numerical modeling for the Mashhad metro line 2 project. Measurements were

performed in the earth pressure balance TBM. Vertical pressure gradients were

measured when the tunnel face encountered with global failure in collapse and

blow-out. The loads acting on the tunnel face were estimated according to the active

and passive earth pressure principles. It is found that the use of varying face support

pressure causes the size of the disturbed zone in proximity to the face is affected.

Detailed discussions are given considering tunnel face displacements (extrusion).

Keyword: Earth pressure balance (EPB) shield, numerical modeling, finite difference

method (FDM), Mashhad metro, Face extrusion

1. Introduction

High portion of soil deformation and surface settlement during the tunnel excavation

process can be associated with the inward movement of the tunnel face. If the

geological conditions are unfavourable in tunneling, such as soft or granular soil, an

additional means for the tunnel face support has to be employed. This can be achieved

by applying the supporting pressure to the tunnel face by pressurized slurry or

compressed air. After this, a series of papers dealing with the tunnel stability, tunnel

face stability and the failure mechanism of the face could be found in various journals

(for example [1]). Several authors have tried to model the effect of shield using a

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numerical modeling tools [2,3]. Some machines show low flexibility as to geometry

shape and curvatures in the tunnel line. The main purpose of the research program

presented in this paper was to investigate the stability of the tunnel face supported by

the earth pressure balance TBM, to determine the supporting pressure at the collapse

and blow-out to observe the failure mechanism and to identify the critical zone ahead

of the tunnel face. The objective was achieved by numerical modeling. The earth

pressure of working face is classified into two kinds of types. The first class is active

earth pressure, which is from the active action of earth pressure to the shield structure

if the thrust force of shield is less than composite force of active earth pressure. The

second class is passive earth pressure, which is from the active action of shield

structure to the earth mass in front of working face if the thrust force of shield is

greater than composite force of active earth pressure. To investigate the behavior of

the Mashhad metro tunnel face subjected to support pressures (ranging from 10% to

200% of lateral earth pressure, ) a numerical study was carried out to examine the

effect of face support pressure on the size of the disturbed zone in proximity to the

face.

2. Mashhad metro project

Excavation of a long tunnel is a major component of Mashhad metro project. The

excavation of the tunnels is to be performed by an earth pressure balance shield

machine with an outside diameter of 9.15 m. The shallowest ground section is a

cover-to-depth ratio (C/D) of 1.17, where C and D are the cover depth and diameter of

the tunnel. Because of the unfavorable geological conditions and the dimension of the

excavating face, the face stability of the tunnel is one of the key technical aspects in

this project. For the detailed design of the tunnel, a comprehensive geotechnical

investigation was completed, which consisted of undisturbed sampling, cone

penetration tests, standard penetration tests and pressuremeter tests. According to the

site investigation results, Mashhad soils can be differentiated into a number of

well-defined strata based on physical properties and soil types, as illustrated in Table

1.

Table 1. Physical and Mechanical Properties of the Tunnel Host Media

Layer Soil type

Ko

E ν φ C γ

bulk

- MPa - degree KPa KN/m

2

I SC-SM 0

.

43 80 0.3 35 0 19.6

II GC-GM 0.36 100 0.28 40 11 19.8

III CL-ML 0.61 30 0.34 20 25 18.2

3. Numerical modelling of face stability

In order to demonstrate the fundamental three-dimensional aspect of the problem

a comprehensive numerical study was conducted employing the FLAC3D code [4].

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The soil layers are assumed to be an elastoplastic material conforming to the

Mohr-Coulomb failure criteria. It is assumed the tunnel is driven by means of an earth

pressure balance TBM in soft soil. Figure 1 shows the different components of the

constructed numerical model. Neglecting the deformations of the shield skin, the

TBM was modelled as a rigid contact body. The length of the shield was assumed to

be 10 m with regard to the TBM specifications. The step-by-step excavation process

was modelled by repeated rezoning of the element mesh at the cutting face and

repeated insertion of elements representing the tunnel lining and the tail void grout,

respectively. Furthermore, the boundary conditions for the face support and the

grouting pressure were adjusted according to the progress of the simulated tunnel

advance. The elements of the grout are directly connected to the elements of the

tunnel lining on the inner side and the soil on the outer side. The concrete lining

was ,therefore, modelled in a simplified way as a continuous, isotropic, elastic tube.

Grouting pressure distribution is complicated. The grouting pressure was modelled by

pore pressure boundary conditions on the grout element nodes at the shield tail

according to the assumed grouting pressure with a variation of 15 KN/m2/m over the

height. In table 2 the vertical soil pressures at the largest and shallowest depths are

presented. This in order to get an idea of the pressures needed to inject the annular

void during excavation. In this paper, denotes grouting pressure. Table 3 shows

the mechanical properties of encountered materials used in the model.

Table 2. Boundary Pressures for Grout Injection

Tunnel

Top

Bottom

Depth (m)

+ 1022

+ 1013

(kN/m2)

± 149

± 318

Grout pressure (bar)

3.5

5.2

Table 3. Material Models and Parameters Used

Type

Constitutive

model

Thickness E ν φ C ρ

bulk

cm MPa - degree KPa Kg/m

3

Shield elastic 10 210000 0.17 - - 7850

grout Mohr-coulomb 12 40 0.25 35 600 1500

lining elastic 35 30000 0.2 - - 2600

Fig. 1. a) 3-D Finite Difference Mesh, b) Representation of the Different Shield Tunneling Components in the

Model

71

(a)

(b)

3.1. Simulation result

The focus of the analysis was on the face failure mechanism ahead of the TBM.

The freshly excavated soil pressure acting on the tunnel face was considered as a

linearly distributed pressure, which increases with depth according to the density of

the conditioned muck in the excavation chamber. The initial conditioned muck

pressure at the level of the center of the tunnel face is equal to the earth pressure at

rest. The conditioned muck pressure will be increased (or decreased) in every

construction phase, until blow-out (or collapse) occurs. The support pressure acting at

the tunnel face can be seen as a combination of an absolute pressure and the vertical

pressure gradient. The paper deals with the pressure gradients measured, the possible

failure mechanism that determine the size of the disturbed zone in proximity to the

face found. The failure criterion is defined as follows: the construction phase is

considered as the beginning of failure, where for the first time considerable value of

unbalanced force (not equal to 0) is observed, as shown in Figure 2.

Fig.2. The Failure Criterion of Numerical Modeling

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Figure 3 shows the pressure measurement inside the tunnel for the actual face

pressures are lower than the free field horizontal stresses. There was a sudden drop in

the measured pressure as the construction phase i, was initiated. This is attributed to a

very small deformation of the ground around the tunnel face at the early stage of the

unloading. The ground deformation, due to the high stiffness at very small strain level,

did not compensate for the volume lose caused by the excavation being driven from

the tunnel. The moment of the collapse is also indicated in Figure 3. There is a sudden

increase in the tunnel face displacements (extrusion), which can be clearly identified.

The collapse pressure ranged from 50 to 75 kPa measured at the center of the tunnel.

Figure 3. Numerical Measurements at the Moment of the Collapse

The following measurements where performed at the tunnel face. The total

pressure was measured at the tunnel face at 9 locations, see Figure 4.

Figure 4. Position of Different Points at the Tunnel Face

Beginning of

the failure

Beginning of

the failure

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The vertical pressure gradients determined from these varying face support pressures

are shown in Figure 5. It shows that the gradient can be high during excavation when

the actual face pressure is more than the free field horizontal stresses but decreases

when the actual face pressure is lower than the free field horizontal stresses. The

values measured for the vertical gradient at varying face support pressure can be put

in perspective realizing that the gradient of the total vertical pressure in the not yet

excavated soil approximately 13kPa/m. The measurements showed that the measured

gradients can higher than 15kPa/m, but also lower than 10kPa/m. Unlike in the active

state ( ), the face support pressure decreases during the failure of the ground

(Figure 5b). But the varying vertical gradient in the both of the passive and active

state is similar (Figure 5c). The measurements showed that the measured gradients

can higher than 15kPa/m, but also lower than 10kPa/m.

Figure 5. (a) Pressures measured at the tunnel face in the passive state , (b) Pressures measured at the

tunnel face in the active state , (c) and the gradient determined from the pressure measured at the tunnel

face in the passive and active state . All readings (E1-E9) are used to calculate the gradient

Tunnel Face

74

(a)

(b)

(c)

3.2. Tunnel face extrusion

Lunardi [5] has shown that the deformations of the tunnel face can be a useful

indicator to evaluate the ground response. In Lunardi's approach, deformations

associated with the tunnel excavation are classified as: (1) pre-convergence, (2) face

extrusion and (3) radial convergence. Figure 6 shows developing extrusion for

varying face support pressure, which were then to become widespread in tunneling as

an accompaniment to more traditional convergence measurements. 15m long into the

face with measurement points fitted at 1metre intervals. The results of the extrusion

measurements taken, significantly increased our theoretical knowledge of the

stress-strain behavior of a tunnel at the face and confirmed the effectiveness of the

face support pressure in controlling deformation behaviour. As shown in Figure 6 the

use of varying face support pressure causes the different size of the disturbed zone in

proximity to the face is affected. In the both of the passive and active state the size of

the disturbed zone in proximity to the face increases, but it is more significant for the

active state, see Figure 6b. For passive state 15m long size of the disturbed zone and

75

active state 20m measured (see horizontal axis Figure 6a,b).

Figure 6. (a). Extrusions Along Horizontal Distance from Tunnel Face for Different Face Pressure

(a)

(b)

Figure 7 shows the extrusion measurements at a distance from the face. The figure

illustrates that there is a plastic zone surrounded by an elastic zone (also known as

confined yield zone). As the face support pressure decreases, the confined yield zone

extends from the tunnel face to the surrounding soil mass. It shows good agreement

with the fact that the largest plastic strains (passive and active state), and hence the

largest displacements (extrusions), develop around the tunnel face.

Figure 7. Face Extrusion for Different Face Support Pressure

3. Conclusion

The obtained results from the conducted analyses demonstrate the complexity of

the various interactions involved in shield tunneling.

 The zone affected by the collapse was found to be between 1.5D ahead the tunnel

face and 2D in the passive state.

 It appears that the uniformly disturbed pressure acting on the tunnel fac e is a

very efficient stabilizing tool. However, in the event of a sudden lost of

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supporting pressure, the collapse will occur suddenly without any warning,

affecting a relatively large zone immediately after the commencement of the

ground movement at the face.

 The vertical pressure gradient isn't to a certain extend influenced by the different

face support pressure.

 The vertical pressure gradient can be lower or higher for a EPB than for a slurry

shield.

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ACCMES 109

Simulations of Control Characteristics of Tuned Liquid Column

Damper Using an Elliptical Flow Path Estimation Method

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Abstract

The simulations of tuned liquid column damper (TLCD) and its variation known as

liquid column vibration absorber (LCVA) are presented in this study . The numerical

simulation carried out in this paper is based on the elliptical flow path estimation

method. This newly proposed numerical model is capable of representing the

vibration characteristics of the TLCDs and LCVAs with relatively large transition

zone between the vertical columns and the cross-over duct. A series of tests on a

shaking table are also conducted. Based on correlation studies between numerical and

experimental results, it is shown that the proposed numerical model is able to emulate

the experimental results. This feature is essential in the control problem for optimum

performance of a tall building. Furthermore, the elliptical flow path estimation

method can be utilized to investigate their efficiency as a vibration absorber .

Keyword: LCVA, TLCD, Shake table, Elliptical flow path estimation method,

Natural frequency

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ACCMES 148

Response analysis of strike-slip fault movement on buried pipeline

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Abstract

A 3D distinct element method (DEM) and finite element method (FEM) analysis has

been carried out to examine the response of buried pipeline accounting for fault

displacement. Around 0.62 million spherical particles are used to create the model and

DEM simulation has been performed for the stabilization of granular assemblies.

Subsequently strike slip fault movement is applied to the model. Pipe is represented as

three dimensional beam element and fixed boundary condition are applied at the

anchored point of the pipeline. Dynamic behavior of pipes and particles has also been

thought in the analysis. The deformation responses of the pipeline are analyzed in

this paper. Force-displacement relationship between pipes and soil particles play an

important role for the modeling and design of buried pipes. In this study, the

relationship between force and displacement are well thought out. The interaction

between soil particles and pipe elements are understandable from this numerical

simulation. The effect of particle movement on pipe deformation responses are also

studied and found that the particle shows greater effect near the fault crossing point.

Finally a parametric study has been performed to understand the effect of different

pipe properties for the same strike slip movement.

Keywords: Buried pipe, Soil-pipe interaction, Strike-slip, Force-displacement,

Discrete element method.

1. Introduction

Pipeline systems, served as water supply and wastewater facilities, natural gas and

liquid fuel lines, power and communication lines, generally play an important role in

the daily life system. These pipelines are referred to lifeline systems as they are

essential for the support of life and maintenance of property. Seismic behavior of

buried pipeline is entirely different from the above ground structures. Surface faulting

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has been a major cause of pipe damages during past earthquakes [1-2]. Damage of

structures by seismic fault is attracting concern for many researchers in recent times

[1].

Seismic response analysis of buried pipes is a complex phenomenon including three

dimensional dynamic analysis of soil-structure system. A rigorous analysis satisfying

all the conditions is almost impossible; hence different degrees of simplifications are

made to obtain a good estimate of the response quantities of interest. Researchers

have been presented different types of models and analytical techniques to obtain the

response of buried pipelines owing to fault movement depending upon types of model

and response quantities of interest [3-6]. However a number of researchers performed

numerical study of buried pipe for different fault rupture and also done parametric

study to fully understand the behavior of the pipe for fault slip using commercially

available analytical tools [7-9]. Apart from the numerical simulation some large scale

experimental investigations [1, 10-11] like centrifuge test and shaking table test has

also been performed to identify the vulnerability parameters and failure criterion of

pipes subjected to fault displacement.

Almost all the researches in buried pipes were carried out by using finite element

method (FEM) in which pipe was considered either beam or shell element or soil

surrounding the pipeline was modeled using non linear springs, which support the

pipeline at discrete points. Conversely soil pipe interaction is the main concern in the

field of buried structures. Apart from using simple spring system, distinct element

method (DEM) is a powerful tool for representing the granular media and has been

proved by many researchers [12-13]. This research study used DEM technique for the

more rational analysis of granular materials and numerical simulation has been

performed to obtain the response of pipelines subjected to strike slip fault. The

behavior of force-displacement has also been described in detail in this research

paper.

2. Numerical Modeling

An important tool in modeling the behavior of granular assemblies is the discrete

element model (DEM), developed in 1970’s by Cundall and Strack [14]. DEM

simulations can be used to determine all kinds of properties of granular assemblies.

Particles are connected to their adjacent particles using normal and shear springs and

dashpots. The rheological elements of DEM are illustrated in Figure – 1(a).

80

(a) (b)

Figure-1: (a) Rheological model of DEM, (b) Schematic illustration of rolling

resistance

Iwashita and Oda [15] proposed additional rotational spring-slider system in parallel

with the normal contact spring. This contact model is schematically presented in

Figure–1(b). Spherical particles with normal, shear & rolling springs and normal and

shear dashpots [16] were exploited in this research. Normal forces are calculated

when particle overlap and maximum shear force and moment are given in the

following:

………. (1)

………. (2)

Where, is the normal force, is frictional coefficient, B is contact area, is a

parameter which determines the rolling resistance.

Pipe is placed in shallow depth in this analysis. Particles contact with pipes during the

DEM simulation and force between pipes and particles are calculated using principle

of mechanics. Pipe is modeled as 3D beam element and there are six degrees of

freedoms at each nodal point. Stiffness matrix, mass matrix and damping matrix are

formulated and the fundamental equation for the pipeline is given in equation 3.

………. (3)

3. Proposed Model

Deformation of buried pipeline is analyzed by developing a three dimensional

modeling of soil and pipes. 618460 spherical particles with diameter 1.0 cm are used

to build up the model and represented the soil assemblies. The basement and sidewalls

are also made of spherical particles of 1.0 cm diameter and assumed to be rigid in the

analysis. Periodic boundary conditions are given at outer edges in X direction so that

any particle goes beyond the boundary is placed at the opposite edge. The size of the

81

model after the preparation process are 61cm x 181 cm x 48.5 cm. Pipe was placed in

shallow depth in this model in such a way that it remained fully buried condition after

the sedimentation process. As this research study intended to use the realistic

properties of pipes and particles, a number of literature review and design guideline

are necessary to fix the pipe properties. Afterward ductile iron pipe (DIP) having

diameter, d= 10 cm and elastic modulus, E=1.6 x 10

11

N/m

2

are selected for this

model. Pipe is divided into 15 equal elements and completely fixed boundary

conditions are imposed. Seismic fault plane is considered perpendicular to the pipe

horizontal axis and divides the whole model in two equal parts. After the

sedimentation of soil particles, strike slip fault movement has been pertained on the

model. Properties of sandy soil have been used to calculate the stiffness of the

particles for this numerical simulation. Density of the particles is assumed as 2.4

g/cm

3

in the analysis and void ratio of the model after the sedimentation process is

found to be, e = 0.194. The parameters used for the particles are shown in Table-1.

Layout of the proposed numerical model is outlined in Figure-2.

Figure- 2: Layout of proposed model

Table-1: Parameters of the analysis

Parameters Value

Normal stiffness constant 2.2 x 10

5

N/m

Tangential stiffness constant 6.1 x 10

4

N/m

Normal damping constant 3.5 N.s/m

Tangential damping constant 2.0 N.s/m

Time step 0.000008

4. Result

4.1 Deformation response of buried pipeline

Deformed profile of the pipeline for different fault displacement is illustrated in the

Figure-3. Fixed boundary conditions are given at the far end of the anchored point of

the pipeline and preset displacements are given to those points as the same magnitude

of fault slip.

82

-100 -50 0 50 100

-10

-5

0

5

10

Distance from fault (cm)

Deformation (cm)

fault displacement = 1 cm

fault displacement = 5 cm

fault displacement = 10 cm

fault displacement = 15 cm

fault displacement = 20 cm

Figure-3: Deformation response of pipe

The above statement can be clearly elucidated in Figure-4. Horizontal axis represents

the distance from fault plane and vertical axis shows the force between pipes and

particles. The forces are higher near the fault crossing points stated the effect of

particles on pipe deformation i.e. particles near the crossing point pushes the pipes to

deform more. The particles show finer effect on pipes up to the fault displacement of

10 cm. Subsequently, the much less effect of particles is seen and boundary conditions

can contribute to the pipe displacement. However, the specific aim of this research is

to investigate the particle movement & its effect on pipe responses and the results

presented in Figure-3 & 4.

-80 -60 -40 -20 0 20 40 60 80

-200

-150

-100

-50

0

50

100

150

200

Distance from fault (cm)

Force (N)

fault displacement = 1 cm

fault displacement = 3 cm

fault displacement = 5 cm

fault displacement = 7 cm

fault displacement = 9 cm

-80 -60 -40 -20 0 20 40 60 80

-200

-150

-100

-50

0

50

100

150

200

Distance from fault (cm)

Force (N)

fault displacement = 12 cm

fault displacement = 14 cm

fault displacement = 16 cm

fault displacement = 18 cm

fault displacement = 20 cm

Figure-4: Force between pipes and particles

83

The maximum force between pipes and particles at different nodal points of pipe

elements for different fault displacement are observed at a distance 20-50 cm from the

fault line and are opposite magnitude on either side of the fault plane and exhibits

lower contribution near the boundary of the model.

4.2 Force displacement relationship

One of the key points of this research study is to describe the soil pipe interaction.

Soil pipe interaction is described by the force displacement relation between pipes and

particles. The conventional force-displacement correlation of soil springs in axial,

horizontal and vertical direction follows the linear relation up to the yield point and

beyond that constant force appears. Most of the research work in buried pipe

analysis uses this type of soil springs to represent the soil behavior. This research

study established the load-deformation relation between pipes and particles which

comes from the movement of particles and contacting forces between the particles.

Force-displacement relations at different nodal points of the pipelines are outlined in

Figure-5 where horizontal axis represents the nodal displacement and vertical axis

corresponds to the force between pipes and particles.

0 1 2 3 4 5

0

50

100

150

200

Displacement(cm)

Force(cm)

Distance from fault: -6 cm

Distance from fault: -18 cm

Distance from fault: -30 cm

0 2 4 6 8 10

-50

0

50

100

150

200

Displacement(cm)

Force(cm)

Distance from fault: -42 cm

Distance from fault: -54 cm

Distance from fault: -66 cm

Distance from fault: -78 cm

Figure-5: Force-displacement relation between pipes and particles

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Force-displacement curve near the fault line shows the initial rising up the force with

the displacement and after the peak, force value goes down and exhibits strain

softening behavior. Movement of soil particles with the fault slip governs the

characteristics of the force response between pipes and particles. The decreasing trend

of the force near the fault crossing point enhances the possibility of brittle failure of

the particles whereas away from the fault crossing point shows the gradual increment

of forces. In Figure-5, load deformation behavior of the pipes greater than 42 cm from

the fault line exemplify the gradual rising up of force rather initial rising up and show

signs of strain hardening behavior. Thus at the far away from the fault line, particle

deformation shows ductile behavior rather than brittle nature. Typical load

deformation curve only explain the behavior up to the yield points though this

research study includes the natural behavior of particles and relies on the naturally

occurring load –deformation relation.

-80 -60 -40 -20 0 20 40 60 80

-0.5

0

0.5

Distance from fault (cm)

Relative displacement (cm)

fd = 4.0 cm

fd = 6.0 cm

fd = 8.0 cm

fd = 10.0 cm

-80 -60 -40 -20 0 20 40 60 80

-1

-0.5

0

0.5

1

1.5

Distance from fault (cm)

Relative displacement (cm)

fd = 12.0 cm

fd = 14.0 cm

fd = 16.0 cm

fd = 18.0 cm

fd = 20.0 cm

Figure-6: Displacement of particles

Displacement of contacting particles with the pipes is also observed and shown in the

Figure-6 where horizontal axis gives the distance from fault and vertical axis

represents relative displacement between pipes and particles. Legend ‘fd’ in the figure

explains the amount of fault slip given to the model. Particle movement plays an

important role in this analysis. Maximum relative particle movement observed near

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the fault rupture up to the distance of 40 cm from the fault line and particle moves in

the strike direction up to the fault movement of 10 cm. Subsequently displacements of

particles are fewer with the increment of strike slip. Figure-6 can explain the

load –deformation behavior of the pipes more clearly showing the initial increment of

particles relative displacement and beyond that the decrement of the particle

displacement resulting the force responses between pipes and particles. Instead of

using the predetermined spring to represent the soil, this type of analysis considering

the contact between pipes and particles may give better understanding of the relation

between soil and pipes.

5. Parametric Study

Vulnerability of buried pipeline due to surface faulting is a vital factor in designing

and installing underground pipeline for practical uses. Underground pipeline generally

extends over long distance through the wide variety of soils, geological conditions

and regions with different seismicity. Consequently there are some influence factors

on the response of pipeline account for fault rupture propagation. The critical factors

are burial depth, soil properties, fault angle, nature of rupture propagation, position of

water table and pipe properties etc. To understand the above parameters clearly, a

series of parametric study is necessary. Most of the researchers are concerned about

the variety of soil properties, burial depth, fault angle etc. But effects of different

pipes properties are playing an important function of the parametric study. This

research study includes a short parametric study using different pipe properties.

5.1 Pipe properties

For this parametric study, four different models are considered with different types of

pipe properties. Herein these four different types are used for the same model and

responses of the pipes are compared for same strike slip fault movement. Typical

properties of those commercially available pipes are taken for the analysis and

presented in Table-2.

Table-2: Parameters for different model

Pipe types Density (kg/m

3

) Elastic modulus (N/m

2

)

Model-1 (DIP) 7850 1.6 x 10

11

Model-2 (PVC) 1300 3.4 x 10

9

Model-3 (HDPE) 950 8.0 x 10

8

Model-4 (Concrete) 2400 3.0 x 10

10

5.2 Result of parametric study

Axial strains with the incremental fault displacement for the four models are

illustrated in Figure-7. HDPE pipes give higher strain in compare with the other

models. This may happen due to the low density and elasticity of the HDPE pipes.

DIP pipe shows much stiff behavior among these four models under the identical

condition of strike slip faulting.

86

-50 0 50

-2

-1

0

1

2

x 10

-3

(a)

Distance from fault (cm)

Strain

Model-1

Model-2

Model-3

Model-4

-50 0 50

-4

-2

0

2

4

x 10

-3

(b)

Distance from fault (cm)

Strain

Model-1

Model-2

Model-3

Model-4

-50 0 50

-0.01

-0.005

0

0.005

0.01

(c)

Distance from fault (cm)

Strain

Model-1

Model-2

Model-3

Model-4

-50 0 50

-0.02

-0.01

0

0.01

0.02

(d)

Distance from fault (cm)

Strain

Model-1

Model-2

Model-3

Model-4

Figure-7: parametric study for strain, (a) fault displacement =2 cm, (b) fault

displacement = 4cm, (c) fault displacement = 12 cm, (d) fault displacement =20cm

-80 -60 -40 -20 0 20 40 60 80

-150

-100

-50

0

50

100

150

(a)

Distance from fault (cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

-80 -60 -40 -20 0 20 40 60 80

-150

-100

-50

0

50

100

150

200

(b)

Distance from fault (cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

-80 -60 -40 -20 0 20 40 60 80

-200

-150

-100

-50

0

50

100

150

200

(c)

Distance from fault (cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

-80 -60 -40 -20 0 20 40 60 80

-200

-150

-100

-50

0

50

100

150

200

(d)

Distance from fault (cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

Figure-8: Force responses (a) fault displacement =2 cm, (b) fault displacement = 4cm,

(c) fault displacement = 12 cm, (d) fault displacement =20cm

The effect of forces between pipes and particles for different models describes the

response of the four models. Maximum forces are observed near the fault line for all

types of models but with different force magnitude. The force responses are varied

with the different stiffness of the pipes accordingly. The above mentioned statements

are graphically presented in Figure-8 where horizontal axis represents the distance

from fault and vertical axis corresponds to the force between pipes and particles.

Larger force observed for the Model -1 with the increment of fault displacement

whereas in case of Model-4, the force response is lower than other models. The effect

of low stiffness of the pipes leads to much deformation for Model-2 and Model-3.

Force-displacement behavior of pipes at different nodal points is also studied in this

research and some are given in Figure-9. DIP gives the higher yield value in compare

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with the other models. As the particle properties remain unchanged in all four models,

the variation of the responses among these four models thus govern by their properties

i.e. stiffness of the pipes. However, HDPE pipe gives the smaller yield value than

other type of models. Strain softening may observed after the yield near the fault line

whereas away from the fault line pipe responses shows much ductile behavior in all

cases.

0 0.5 1 1.5 2 2.5 3 3.5

0

20

40

60

80

100

120

140

(a)

Displacement(cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

0 1 2 3 4 5 6

0

20

40

60

80

100

120

140

160

180

(b)

Displacement(cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

0 1 2 3 4 5 6 7

0

50

100

150

200

(c)

Displacement(cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

0 1 2 3 4 5 6 7 8 9

-50

0

50

100

150

200

(d)

Displacement(cm)

Force(cm)

Model-1

Model-2

Model-3

Model-4

Figure-9: Force-displacement relation, (a) Distance from fault: -18 cm, (b) Distance

from fault: -30 cm, (c) Distance from fault: -42 cm, (d) Distance from fault: -54 cm

6. Conclusion

A three dimensional numerical simulation of buried pipe has been performed for the

response analysis of pipes buried in shallow depth. Pipe deforms with the movement

of particles at the time of fault rupture and exhibits strain increment accordingly with

the fault slip. Particles near the fault line shows greater effect on the pipeline.

Load-deformation relation between pipes and particles are also observed and

discussed in this paper. The relation seems to be understandable and compatible with

the typical load –deformation curve. Afterward a short parametric study has been

performed with different commercially available pipe types and in the analysis DIP

pipe shows better performance against ground rupture. However, limitation of

computational time may be an obstacle for more rigorous analysis of this simulation.

Simulation of larger model with smaller size particle can overcome the current

obstacle of the simulation and be a more rational analysis.

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Optimum Cross-Sectional Floating structure

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Abstract

In the present study, numerical analysis of pontoon-type, combination-type and

hybrid-type floating structures(240\*240\*14) are carried out through ANSYS AQWA

in water depth 35m. The six degree motions of structure such surge, sway, heave, roll,

pitch, yaw is investigated for fifth cases, which divided the wave period from 5sec to

15sec in regular wave. Since the structure is a square shape, the numerical analysis is

only performed in case of incident wave angle 0 and 45 degrees. From the comparison

between pontoon and hybrid floating structure, it is found that the combination-type

floating structure is very effective to reduce the motion of structure for all cases.

Keyword:Floating structure, Hybrid, Hydrodynamic analysis, ANSYS AQWA,

RAOs.

1. Introduction

In recent years, construction practices of floating structures such floating offshore

structures as floating LNG terminals, container terminals, oil production and storage

facilities, and floating breakwaters have increased around the world, resulting in

active progress of researches on the floating structures. The structural type of the

floating structures can be divided into pontoon type and semi-submergible type. First,

the pontoon type makes it easy to secure buoyance, and its internal space can be

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utilized as storage use. In addition, it has widely been applied worldwide due to its

advantages of simple structure and economic (Allen et al., 2006; Haveman et al., 2006;

Jeong et al., 2010). However, the pontoon-type floating structure can’t absorb the

impact energy of wave load due to the closed sides, which generates severe

(a)Pontoon type (b) Hybrid type

Figure 1. Shape of unit modules

hydrodynamic motion resulting by the wave loads (Jeong et al., 2010; Zijian, 2007).

In case of semi-submergible type, the flow of seawater is possible due to the

installation of air gap in the floating structures, because of this, advantage of its insta

llation and utilization even under extreme wave environment. However, it has the

disadvantage of increase in the height of the structure itself due to the obtainer of

buoyancy and installation of an air gap. To complement the problems of the two types,

a hybrid floating structure was developed, and furthermore, a combination floating

structure was proposed. In case of the combination floating structure, its disadvantage

was complemented through combination with a pontoon-type floating structure to

obtain buoyancy.

Table 1. Dimension of unit module

Pontoon Hybrid

Length(m) 30 30

Breath(m) 30 30

Height(m) 14 14

Cylinder Diameter(m) None 20

Thickness

Top/Bottom Slab(m) 0.65 0.65

External Wall(m) 0.65 0.50

Internal Wall(m) 0.30 None

In this study, an analysis on the pontoon-type, hybrid-type and combination-type

floating structures with size of 240(L)×240(B)×14(H) was conducted, targeting the

coast with water depth of 35m. The hydrodynamic motion characteristics under

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different 50 wave loads at 5 to 15 seconds of wave period that can occur in the

targeted coast were investigated. In case of the wave angle of incidence, an analysis

on the two directions of 0° and 45° was conducted in consideration of a square-shaped

floating structure. The wave-induced motion were identified through hydrodynamic

analysis, and its analysis was carried out using ANSYS AQWA, the universal analysis

program.

(a) Pontoon-type (b) Combination-type (c)Hybrid-type

Figure 2. Analysis model

2. Numerical Analysis

2.1 Hydrodynamic Analysis Program ANSYS-AQWA

The analysis software AQWA used in this study is a program that performs

dynamic behavior analysis of offshore structures like vessels and floating objects

against external forces of marine environment such as wave, wind and current as a

universal program of ANSYS Inc. and it enables various kinds of analyses,

including LINE, LIBRUM, FER, NAUT and DRIFT. First, LINE analysis is a

three-dimensional diffraction and radiation analysis program, and it is used to

calculate wave force and structure response. LIBRUM analysis performs eigen-mode

and dynamic stability analysis, and FER, NAUT and DRIFT analyses conduct

mooring tension analysis and movement of structures.

In this study, the RAO(Response Amplitude Operator) on the each direction of

pontoon-type and hybrid-type floating structures against wave loads applied through

AQWA LINE analysis was deduced, and analytical verification on the movement

reduction effects of Optimum Cross-Sectional floating structure was conducted

through a comparative analysis on the analysis results..

2.2 Analytical Model

The analysis target structure of this study is a concrete floating quay wall, and

detailed specifications of the concrete floating structure is based on the cross-section

derived from the actual design(KICT , 2010). The basic specifications of the unit

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modules that constitute the target floating structure are shown in Figure 1 and Table 1.

The size of the floating structure is length(Ls) 240m, breadth(Bs) 240m and height(Hs)

14m, and the shapes of floating structures, the analysis models in this study are shown

in Figure 2. As identified in figure 2, (a) pontoon-type floating structure is a floating

structure whose entire structure is composed of pontoon-type unit modules of Figure 1

(a), and (c) hybrid-type floating structure is a structure in which only hybrid modules

of Figure 1 (b) are combined. In addition, the combination-type floating structure of

Figure 3 (b) is the one whose central part is 120\*120 pontoon-type and outer part is

made of hybrid-type. An analysis on the coast with water depth of 35m was carried

out under marine environmental conditions for the hydrodynamic analysis, and among

various external forces of the marine environment, only the effect on the wave loads

that have the most impact on the motion of floating structures was examined.

The wave loads applied to the hydrodynamic analysis, the 50 wave loads at 5 to 15

seconds of wave period were applied. In addition, an incidence angle (β) of wave

length was considered toward the two directions of 0and 45 degrees and the

hydrodynamic motion of each floating structure according to the incidence angle were

compared. The hydrodynamic motion of each floating structure were identified

through a comparative analysis of RAOs that occur in the floating structures. In this

study, an analysis was carried out using ANSYS AQWA, the hydrodynamic universal

analysis program, and the target floating structure was modeled with 3D-Shell

elements.

3. Analysis Results and Discussion

The AQWA-LINE analysis on the 50 wave loads of 5 to 15 seconds that can occur

in the coast with water depth of 35m was carried out. In addition, the hydrodynamic

motion of floating structure on the each angle of incidence was compared. First,

hydrodynamic force that causes motion of floating structures was investigated.

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(a) surge (b) heave

Figure 3. Excitation force at incidence angle 0 degree

(

a) surge (b) heave

Figure 4. Excitation force at incidence angle 45 degree

Figure 3 represents the excitation force that occurs when the incidence angle is 0

degree.As shown in Figure 3 (a), small excitation force against a surge occurred

compared topontoon-type floating structure. In particular, the wave excitation force of

a combination type greatly decreased between 9 and 13 seconds. Figure 3 (b) shows

the excitation force on the heave, and represents the maximum excitation force in a

hybrid floating structure at 14 seconds of wave period. In addition similar excitation

force occurs in both pontoon-type and hybrid-type. Figure 4 shows the excitation

force that occurs in the floating structures when an incidence angle is 45. Figure 4 (a)

represents excitation force on the surge, and all 3 analytical models show similar

excitation force trends. In addition, the excitation force increased at more than 12

seconds of wave period in case of combination-type floating structure.

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(a) surge (b) heave

Figure 5. Added mass

(a) surge (b) heave

Figure 6. Radiation damping

Among hydrodynamic forces that occur in floating structures, added mass and

radiation damping are shown in Figure 5 and 6. Figure 5 (a) represents added mass in

surge, and the smallest added mass appears in pontoon-type floating structure as

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shown in the Figure. Figure 5 (b) shows the added mass of heave, and it turned out

that all three analytical models indicate similar levels in general, but a sharp decrease

in added mass occurs in hybrid-type floating structure at about 13 seconds.

Figure 6 (a) represents radiation damping on the surge, and the largest radiation

damping appears in pontoon-type floating structure as shwon in the Figure. Figure 6

(b) shows the radiation damping of heave, and it turned out that all three analytical

models indicate similar levels in general, but a sharp decrease in radiation damping

occurs in hybrid-type floating structure at about 13 seconds. Such a result is consid -(a) heave(b) pitch

Figure 7. RAOs at incidence angle 0 degree

(a) heave(b) pitch

Figure 8. RAOs at incidence angle 45 degree

ered to occur due to the interaction between the fluid and cylinder of a hybrid in case

of the long period wave.

The motion of floating structures was examined through a comparative analysis of

RAOs that occur in the floating structures. Among 6 degrees of freedom, an analysis

on the heave and pitch was carried out. Figure 7 and 8 shows the results of analytical

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models that occur when the angle of incidence is 0 and 45, respectively.

As identified in Figure 7 (a), microscopic motion reduction effects appear under

short-period wave loads with wave period of less than 10 seconds, and the larger

motion than pontoon-type floating structure occurs temporarily in case of the heave.

However, the motion of hybrid and combination floating structures decreased in long

period wave with more than 10 seconds. In addition, it was found that the reduction in

motion of combination floating structure is greater compared to that of hybrid floating

structure. Figure 7 (b) represents the motion characteristics of the pitch, and the

distinct motion reduction effects appear in long period wave with wave period of

more than 9 seconds. In addition, the most obvious motion reduction effects were

found in combination floating structure.

Figure 8 represents the heave and pitch RAOs of floating structures when the

angle of incidence is 45°. Figure 8 (a) shows the motion by the heave, and all

analytical models show almost similar motion characteristics. However, microscopic

motion reduction appeared in long period wave with of more than 10 seconds in case

of combination floating structure. Figure 8 (b) represents the motion by the pitch, and

the motion reduction effects of hybrid and combination floating structures can be

identified in long period waves of more than 10 seconds.

4. Conclusion

In this study, a comparative analysis on the motion reduction effects according to

shape of floating structures was carried out, and based on this, the optimum

cross-sectional shape of the floating structures was reviewed. In addition, a

combination- type floating structure was proposed in this study, and its excellent

motion reduction effects by combining the advantages of pontoon-type and

hybrid-type were verified.

1. The motion reduction effects of combination-type and hybrid-type floating

structures turned out to be greater compared to those of general pontoon-type

floating structure.

2. The combination-type floating structure showed the most excellent motion

characteristics of all three analytical models.

3. The combination-type floating structure boasts its easiness of securing buoyancy

due to pontoon-type floating structure in the center.

4. Due to the presence of pontoon-type floating structure in the center, the

combination-type floating structure is subjected to less force caused by the

interaction between the structure-fluid in long period waves compared to the

hybrid-type floating structure.

5. It is considered that the motion reduction effects appear since seawater passes

through a air gap of the floating structure due to hybrid unit modules.

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Hydraulic conductivity of various shape of sands

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ABSTRACT

This study aims to investigate the effects of shape of sands on the coefficient of

permeability (k). The paper presents the results of an extensive series of experimental

investigation carried out in permeablity tests on sands having various shapes. A

particle size range (1.18- 0.6 mm) of five different sands (Leighton Buzzard Sand,

Trakya Sand, Narli Sand, Crushed Stone Sand, Fly Ash Pellets) having distinct shapes

were tested in a constant head permeability testing apparatus at a relative density (Rd

)

of about 35% and constant room temperature (20

o

C). Experimental results showed a

clear relation between the shape of the sands and the hydraulic conductivity values

obtained. Pictures taken show the physical differences/ similarities among the sands

used during this investigation. A comperative study on the tests results and estimated

hydraulic conductivity values using emprical equations derived by numerous

researchers for coefficient of permeability prediction of soils are also presented.

Keywords: Sand, shape, permeability.

1. INTRODUCTION

Water is free to flow through the pores between soil particles in accordance with the

Darcy’s emprical law (q=Aki). The coefficient of permeability (k) or hydraulic

conductivity depends basically on the average size of the pores through the soil matrix,

and temperature of the environment. In general, the smaller the soil grains the lower is

the coefficient of permeability. The presence of a fines content in a coarse grained soil

results in a k value significantly lower than that for the same soil without fines. For a

given soil, the k value is affected by stratification. For example, if a soil deposit is

stratified, the permeability for flow parallel to the direction of stratification is higher

than that for flow perpendicular to the direction of stratification. The k value also

changes with temperature, upon which the viscosity of the water is dependent. Such as,

if the k value measured at 20°C is taken as 100%, then the k values at 10°C and 0°C

would be 77% and 56% respectively (Craig, 1997; Powrie, 2004; Das, 2008). From

clay to cobbles, the k value increases over many orders of magnitude. The typical k

values for different soils are within the ranges shown in Table 1.

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To obtain the k value in laboratory studies, two common laboratory test methods of

constant head for coarse grained soils and falling head for fine graines soils are

employed. In some cases, the in-situ determination of coefficient of permeability may

be required. Such as, well pumping test, which involves continuous pumping from a

well, can be used in homogenous coarse grained soil strata. In borehole in-situ method,

water is allowed to flow into the stratum under constant head. The k value of coarse

grained soil can also be determined from in-situ measurements of seepage velocity,

which involves excavating pits at two different points and taking measurements

between them (Craig, 1997; Powrie, 2004; Das, 2008).

Table 1. Coefficient of permeability, k (m/s), (BS 8004: 1986).

For sandy soils, Hazen, 1892, 1911; Taylor, 1948; Terzaghi and Peck, 1964; Lambe and

Whitman, 1969; Holtz and Kovacks, 1981; Das, 1997; and Coduto, 1999 estimated the

approximate k value by various emprical equations. Kozeny (1927) and Carman (1956)

developed a semiemprical/theoritical formula for predicting the permeability of porous

media. Furthermore, certain geotechnical textbooks cite many more empirical

equations developed for permeability prediction of soils; including Kenney et al.

(1984), Vukovic and Soro (1992), Alyamani and Sen (1993), USBR, (1990), Slichter

(1898) and Chapuis (2004). Actually, these formulas are constrained with some

limitations.

Here in this study, it is aimed to investigate the influences of shape of sands having the

same gradation characteristics (Cc, C

u, D

10, D

30, D

50, D60) on the coefficient of

permeability using a series of experimental results. The paper also aims to present a

comperative study of Kozeny-Carman, Hazen, Terzaghi, Slichter, USBR, Alyamani &

Sen, and Chapuis methods employed for predicting the coefficient of permeability (k)

of soils.

2. EXPERIMENTAL STUDY

The materials used in the tests described in this study were Leighton Buzzard Sand

(LBS), Trakya Sand (TS), Narli Sand (NS), Crushed Stone Sand (CSS), and Fly Ash

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Pellets (FAP), having the distinct shapes falling between 1.18 and 0.6 mm. Figure 1

shows the gradation curve of the specimens. D10, D

30, D

50, and D60 sizes are around

0.64, 0.73, 0.84 and 0.90 respectively. Thus, the coefficient of uniformity (Cu

) and the

coefficient of curvature (Cc) have been calculated as 1.41 and 0.93. Pictures given in

Figure 2 show the physical differences/similarities among the sands used during this

investigation. The sands were tested in a constant head permeability testing apparatus

at a relative density (Rd

) of about 35% and constant room temperature (20

o

C).

Maximum and minimum void ratio values (e

max

, e

min

) were found to be 0.842 and

0.525 for Leighton Buzzard Sand, 0.931 and 0.679 for Trakya Sand, 0.795 and 0.543

for Narli Sand, 1.013 and 0.668 for Crushed Stone Sand, and 1.280 and 0.916 for fly

ash pellets respectively.

The specimens, at the required relative density (35%), are placed in a perspex

cylindrical cell of about 50 cm

2

cross-sectional area (A). The specimens rest on a wire

mesh at bottom of the cell. The volume of the water (q) flowing during a certain time

(t) is measured, when a steady vertical water flow, under a constant head, is

maintained through the soil specimen. Then, k values of the specimens tested were

calculated using Darcy’s law (k=ql/Ah).

0

10

20

30

40

50

60

70

80

90

100

0,01 0,1 1 10 100

Particle size (mm)

Percentage passing ( %)

D

10

= 0.64

D

50

= 0.84

C

u

= 1.41

C

c

= 0.93

Figure 1. Particle size distribution for the geomaterials used during the experimental

study.

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(a) (b)

103

(c) (d)

(e)

Figure 2. Pictures of the geomaterials used during the experimental study (a-Leighton Buzzard Sand, b- Trakya Sand, c- Narli Sand, d- Crushed Stone Sand, e- Fly

Ash Pellets).

3. RESULTS AND DISCUSSION

Table 2 gives a summary of the specimens used in the tests reported here. The initial

relative densities of all specimens were kept around 35%. The specimens were loose to

medium dense.

Table 2. Summary of the specimen data

Gs e

max e

min e

specimen

d

specimen

(g/cm

3

)

ϕ (

o

)

k

(cm/sec)

Leighton Buzzard Sand 2.65 0.842 0.525 0.731 1.530 33 0.322

Trakya Sand 2.65 0.931 0.679 0.843 1.438 36 0.375

Narli Sand 2.68 0.795 0.543 0.707 1.570 38 0.296

Crushed Stone Sand 2.66 1.013 0.668 0.892 1.406 41 0.417

Fly Ash Pellet 1.75 1.280 0.916 1.152 0.813 39 0.597

Figure 3 shows the variation of coefficient of permeability (k) values and void ratio (e)

for the geomaterials tested. The higher k values can be seen for the geomaterials having

higher e values. In general, a mixture of various grain sizes results in lower void ratio.

However, in this study, void ratios depend on the shape of soil grains, as the sands with

different shapes have the same gradation curves. Soil grains exist in many shapes and

these shapes pack together in a variety of ways that may increase or decrease void ratio.

Although, soil packing is effected by many physical properties, perhaps the simplest to

discuss is grain shape. It has been already demonstrated the effect of grain shape on

void ratio (e), internal friction angle (ϕ), and shear strength (τ) values (Zelasko et al.,

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1975; Santamarina and Cascante, 1998; Shinohara et al., 2000; Sukumaran and

Ashmawy, 2001). In general, if the void ratio is high, particle are free to rotate which

results in lower frictional resistance to shearing, and higher k values. In densely packed

soils with low void ratio, higher number of contacts per particle results in an increase in

shearing and lower k values. It is thought that the granular packing in more angular soil

grain samples have a more open fabric than those in relatively rounded soil grain

samples. Grain texture also may affect the permability to a certain extent. Grains with a

rough surface texture can cause more frictional resistance to flow than smooth textured

grains. However, the result obtained here in this study is not consistent with this

statement. The author’s interpretted that the reason of that could be due to the

dispersion of fly ash particles on the pellet grains during saturation phase and testing, or

because of the lower specific gravity value of pellet grains.

0,2

0,3

0,4

0,5

0,6

0,7

0,2 0,4 0,6 0,8 1 1,2 1,4 1,6 1,8

Void ratio (e)

Coefficient of permeability, k (cm/sec)

Narli Sand

Leighton Buzzard Sand

Trakya Sand

Crushed Stone Sand

Fly Ash Pellet

Figure 3. Coefficient of permeability for various sands at 35% of Rd

.

Figure 4 is presented based on the information given by Taylor (1948), which is an

widely accepted illustration between k and e

3

/(1+e). This approach had been previously

developed by Terzaghi (1925) for clayey soils.

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0

0,1

0,2

0,3

0,4

0,5

0,6

0,7

0,8

0 0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8

Coefficient of permeability, k (cm/sec)

e

3

/(1+e)

Fly Ash Pellet

Crushed Stone Sand

1/1

Trakya Sand

Leighton Buzzard Sand

Narli Sand

Figure 4. Relationship between k and e

3

/(1+e) for the sands tested.

0,0

0,2

0,4

0,6

0,8

1,0

1,2

1,4

1,6

0 0,2 0,4 0,6 0,8 1 1,2 1,4 1,6

Measured, k (cm/s)

Predicted, k (cm/s)

Hazen

Kozeny-Carman

Slitcher

Terzaghi

USBR

Alyamani & Sen

Chapuis

1:1

Figure 5. Predicted vs measured k values for the sands tested using various methods.

It is seen from the Figure 5 that Kozeny-Carman’s formula can be of the interesting

approach to focus on since its k values fall away above of the equality line on the plot.

Likewise, Hazen method gave similar high values, may be because of the sorting

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coefficient value (C) in the formula. Although it was intended to verify these

approaches for the purpose of the present study, it is difficult to expect that

Kozeny-Carman and Hazen methods are likely to be consistent with shape of the sands

having same grain size described here. USBR, and Alyamani & Sen’s approaches give

the same k values for all measurements (0.2535, and 0.5691). Actually, the authors

realized that these two methods are not very sensitive to the shape of soil grains

classified as poor graded (SP). That could be because of the limited parameters

employed in the equations. It is also interesting to note from the study by Odong (2007)

that the Vukovic and Soro (1992) method, from which the emprical equations were

derived, is dependent on a unique parameter, the coefficient of uniformity (Cu

). Thus,

the authors have postulated that k values of all the sands tested in this study have been

remain as a constant value; however, in fact they all have different k values.

Accordingly, it may give insight that any system of permability analysis which

neglects the effect of the grain shape will be incomplete. Estimations by Chapuis are

more accurate than the Hazen, and Kozeny-Carman. Overall results showed that

Terzaghi and Slitcher methods are more useful equations to predict fairly well the k

values of the soil samples tested in this investigation. The emprical equations used

during this investigation, and results on the sands tested are presented in Table 3.

Table 3. Emprical equations and their implications on the sands tested in this paper.

Researcher/

Organization

Equation Sample k (cm/sec)

Hazen

LBS

\*

0.6349

TS

-0.7196

NS

+

0.6151

CSS

†

0.7540

FAP

‡

0.9087

Kozeny-Carman

LBS 0.7556

TS 1.0872

NS 0.6926

CSS 1.2566

FAP 2.3808

Terzaghi

LBS 0.3229

TS 0.4220

NS 0.3022

CSS 0.4676

FAP 0.7181

Chapuis LBS 0.4279

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TS 0.4776

NS 0.4541

CSS 0.4466

FAP 0.4751

Slichter

LBS 0.2372

TS 0.3082

NS 0.2224

CSS 0.3408

FAP 0.5175

USBR

LBS 0.2535

TS 0.2535

NS 0.2535

CSS 0.2535

FAP 0.2535

Alyamani &

Sen

LBS 0.5691

TS 0.5691

NS 0.5691

CSS 0.5691

FAP 0.5691

LBS

\*

:Leighton Buzzard Sand; TS

-:Trakya Sand; NS

+

:Narli Sand; CSS

†

:Crushed

Stone Sand; FAP

‡

:Fly Ash Pellet.

4. CONCLUSIONS

In this investigation, a particle size range (1.18- 0.6 mm) of five different sands

having distinct shapes have been tested in a constant head permeability testing

apparatus at a relative density (R

d

) of about 35%. Also, already available empirical

permeability equations have been briefly discussed for the estimation of coefficient of

permeability values (k). Experimental results have showed a clear relation between

the shape of the sands and the hydraulic conductivity values obtained. Differences

between the predicted and measured k values conclude that the methods employed

here are capable but not sufficient for correct prediction of k values. The tests results

reported, and the readily available equations compared here in this paper show the

followings:

(i) Sands having different shapes with the same grading characteristics (Cc, C

u, D

10

,

D30, D

50, D60) result in different k values.

(ii) Different e

max

and e

min

values for the sands having a same gradation curve have

been obtained, due to the properties of grain shape.

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(iii) Relatively rounded soil grains tested (apart from the fly ash pellets) have lower k

values than the angular soil grains have.

(iv) Estimating the k values of soils by using grading characteristics can lead to

underestimation or overestimation, unless the grain shape properties (roundness,

sphericity) are taken into account.

(v) Empirical equations by Terzaghi and Slitcher give more accurate results than the

other equations (Chapuis, USBR, Alyamani and Sen, Hazen, and Kozeny-Carman) employed to predict the k values of the soil samples tested in this

investigation.

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Electrical Engineering I

2013/3/16 Saturday 09:00-10:30 Room 605

Session Chair: Prof. Ansgar Kern

ICEAS 965

Differential Search Algorithm for Economic Dispatch with Valve-Point Effects

Mohd Herwan Sulaiman︱Universiti Malaysia Pahang

ICEAS 1002

Development of Line Following Car using CCD Camera

Wan Rahiman︱Universiti Sains Malaysia

Amre Puasa︱Universiti Sains Malaysia

ICEAS 1038

Difference Grey Sliding-Mode Control of a UPS Inverter for Robust Output

Voltage Tracking

En-Chih Chang︱I-Shou University

Lung-Sheng Yang︱Far East University

Rong-Ching Wu︱I-Shou University

EECS 391

A FPGA-based Space Vector Controller With Power Stage

Ansgar Kern︱Technische Hochschule Mittelhessen

EECS 438

Performance of Grid-connected Hybrid Photovoltaic/Fuel Cell/Battery

Distributed Generation System

Ahmad M. Eid︱Aswan University

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ICEAS 965

Differential Search Algorithm for Economic Dispatch with

Valve-Point Effects

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Abstract

This paper introduces a new method for determining the feasible optimal solution of

Economic Dispatch (ED) problems which is using the recently developed Differential

Search (DS) algorithm. DS algorithm simulates the Brownian-like random-walk

movement used by an organism to migrate. DS will seek for the optimal generation

scheduling when the specific load is known so that the cost can be minimized without

violating any constraints. The cost minimization also will give the significant impact

to the total system losses. To demonstrate the effectiveness and feasibility of DS in

solving ED, two well-known ED test systems with non-convex solution features have

been tested and compared with some of the most recently published ED solution

methods in literature. The results of this research show that DS is able to find more

economical solution than those determined by other methods.

Keyword:Differential search algorithm (DS), economic dispatch, valve-point effects

1. Introduction

Power system is one of the complex systems of human’s invention. One of the most

important issue emerged in power system complexity is Economic Dispatch (ED)

problem. ED is the fundamental problem which aims to find the optimal power

generation to match with the demand at minimum cost by satisfying all the system

constraints. In addition, the practical ED problems which are involving non-convex

objective functions with equality and inequality constraints including the practical

operation constraints of generators such as ramp rate limit, prohibited operating zones

and generation limits make it harder to solve the global optimum using conventional

methods, especially for larger systems. Small improvements in determining the

optimal output scheduling can contribute to significant cost savings. Thus, there are a

lot of researches and techniques have been proposed to solve ED problem.

In recent years, various methods have been proposed to solve ED problem in power

systems: from analytical technique [1, 2] to artificial intelligence approaches[3-7].

Recently, new computational technique called swarm intelligence becoming the

choice of many researchers in solving ED problem, such as particle swarm

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optimization (PSO) [8, 9], firefly algorithm (FA) [10] and artificial bee colony (ABC)

[11, 12]. The modification of PSO namely quantum-behaved PSO (QPSO) [13] and

self-organizing hierarchical PSO (SOH-PSO) [14]also have been tempted to solve

ED.

Although the said methodologies have been developed for ED, the complexity of the

task reveals the necessity for development of efficient algorithms to accurately

locating the optimum solution [10].This paper presents an application of Differential

Search (DS) algorithm for solving non-convex ED problems with the valve loading

effects. In this paper, DS is adopted to find the global optimum results of ED. DS

algorithm simulates the Brownian-like random-walk movement used by an organism

to migrate.

The layout of this paper is organized as follows: The ED problem is briefly discussed in

Section 2. It followed by an overview of DS in Section 3. The proposed DS algorithm

for solving ED is presented Section 4, followed by the case study results and discussion

which are shown in Section 5. Finally, the conclusion is given in Section 6.

2. Economic Dispatch

In the economic dispatch (ED) problem with valve-point effects, the cost function takes

the following form:







n

i

i i

P F f

1

) ( min

(1)

   

i i i i i i i i i i i P P P P P F       

min 2

sin ) (     

(2)

where n is the number of generator units, Pi

min

is the lower bound of Pi

, αi

, β

i

, and γ

i

are

coefficients of generator i, and ε

i

and δ

i

are parameters reflecting the valve-point

effects. The cost function in (2) is subject to the power balanced constraints and

individual generation limits as follow:

L D

n

i

i

P P P   

1

(3)

(max) (min) i i i P P P  

i = 1, 2,…,n (4)

wherePD

is the total load demand, PL

is the total loss and n is the total number of

committed generator during the dispatched hour. Since the power loss is cannot

avoided in interconnected power system, it must be taken into account to achieve as

closed as practical economic dispatch by using the B-coefficient method [15], as

follows:

 

  

  

n

i

n

j

n

i

i i j ij i L B P B P B P P

1 1 1

00 0

(5)

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3. Differential Search Algorithm

DS algorithm is inspired by migration of living beings which constitute superorganisms

during climate change of the year. Migration behavior allows them to move from one

habitat to more efficient habitat. They start to change their position by moving toward

more fruitful areas. The movement of superorganism can be described by a

Brownian-like random-walk model [16].

It is assumed that random solution of population is corresponding to the

artificial-superorganism migration to global optimum solution of the problem. During

the migration, the artificial-superorganism tests whether some randomly selected

position are suitable for temporarily basis. If the position tested is suitable to stop over

for a temporary during the migration, the members of the artificial-superorganism that

made the discovery immediately settle at the discovered position and continue their

migration from this position. DS search strategy may simultaneously use more than one

individual and no inclination to correctly go towards the best solution of the problem

which makes it has a successful search strategy for finding the solution of multimodal

functions. Pseudo-code of DS algorithm can be obtained in [16].

4. Economic Dispatch Using DS

In solving ED using DS, a member of an artificial-organism firstly will be initialized.

This comprises of the number of generations of the system that will be optimized which

resulted a minimum cost by fulfilling all the constraints. The mechanism of finding

stopover site at the areas is using a random searching process. Various random

processes are utilized in DS until the optimal results are found by the migration of

artificial-organisms.

Equations (1)-(2) were applied in the evaluation process of the ED problem. In order to

deal with the inequality constraint: upper and lower limits of each generator, normally

when the solutions obtained out of these boundaries, the algorithm will choose the

boundary values. For equality constraint: power balance constraint, the penalty method

has been used. The penalty value is reflected to the power balance mismatch and

embedded in the cost function (1) as follows:

] ) [( \* ) (

1

L D

n

i

i P P P abs PF F F     



(3)

wherePF is the penalty factor.

The advantage of DS is it has only two control parameter i.e. p

1

and p

2

which is normally

are set to 0.3 [16] which provides the best solution. DS also is very simple.

Nevertheless, to obtain good results, large number of iterations needs to be set in this

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algorithm.

5. Simulation Results and Discussions

The proposed method has been applied to two test systems: a power system with

13-units and TAIPOWER 40-unit systems. The proposed method is compared with the

recent techniques reported in literature.

5.1 13-units system

This test case consists of 13 generating units. The load demand of this test system is

1800 MW. The same parameters data of all units as given in[6] is utilized. Table 1

shows the best, average and worst results of different ED solutions methods. The

outcomes of other methods shown in Table 1 have been directly quoted from the

corresponding references. It can be seen that the best result of proposed method is

slightly better compared to FA.Nevertheless, the overall performance of DS in term of

average and worst is much better among the others reported. A detailed power

generated by individual unit for proposed method and FA is shown in Table 2.

Table 1: The best, average and worst of different ED solution methods for the

13-units test system

Methods Best ($/h) Average ($/h) Worst ($/h)

CEP [6] 18,048.21 18,190.32 18,404.04

PSO [9, 10] 18,030.72 18,205.78 NA

MFEP[6, 10] 18,028.09 18,192 18,416.89

HS [7] 17,965.62 17,968.563 18,070.176

FA[10] 17,963.83 18,029.16 18,168.80

DS 17,963.8292 17,966.6968 17,968.9467

Table 2: Individual power generation in the best result of proposed DS versus FA

for the 13-units system

Unit DS FA

Power (MW) Power (MW)

1 628.3185307 628.31852

2 149.5996165 149.59952

3 222.7491063 222.74912

4 109.8665494 109.86655

5 60 109.86655

6 109.8665498 109.86655

7 109.8665484 109.86655

8 109.8665493 60

9 109.8665496 109.86655

10 40 40

11 40 40

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12 55 55

13 55 55.00009

Total generation (MW) 1800 1800

Cost ($/h) 17963.829207639 17963.8307965424

5.2 TAIPOWER 40-units system

This test case consists of 40 generating units with non-convex fuel cost function

incorporating valve loading effects. The required load demand to be met by all 40

generators is 10500 MW. Again, the detailed information of generating units of test

system can be obtained in [6]. This test system is more complex than the previous case

and any difference between ED solution methods can be better revealed in this test case.

The DS has been executed for twenty times with various initialization of starting points.

The obtained results of the proposed DS to resolve ED problem for this test system are

tabulated in Table 3. In this table, the detailed comparisons of the best, average and

worst solutions of the proposed DS and most recently published ED solution methods

are shown by referring to the [10]. As seen from Table 3, the best solution of proposed

method is better than those of all methods, indicating DS’s higher efficiency to solve

ED problem comparing with the other methods. Thus, the proposed method is proved to

be the best among all methods so far. Due to the space constraint, the detailed results of

the optimal solution of the proposed method including generation output of each unit

for this test system isnot given.

Table 3: The best, average and worst of different ED solution methods for the

TAIPOWER 40-units test system

Methods Best ($/h) Average ($/h) Worst ($/h)

HGPSO 124,797.13 126,855.70 NA

PSO 124,350.40 126,074.40 NA

SPSO 123,930.45 124,154.49 NA

CEP 123,488.29 124,793.48 126,902.89

HGAPSO 122,780.00 124,575.70 NA

FEP 122,679.71 124,119.37 127,245.59

MFEP 122,647.57 123,489.74 124,356.47

IFEP 122,624.35 123,382.00 125,740.63

TM 122,477.78 123,078.21 124,693.81

EP–SQP 122,323.97 122,379.63 NA

MPSO 122,252.26 NA NA

ESO 122,122.16 122,558.45 123,143.07

HPSOM 122,112.40 124,350.87 NA

PSO–SQP 122,094.67 122,245.25 NA

PSO-LRS 122,035.79 122,558.45 123,461.67

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Improved GA 121,915.93 122,811.41 123,334.00

HPSOWM 121,915.30 122,844.40 NA

IGAMU 121,819.25 NA NA

HDE 121,813.26 122,705.66 NA

DEC(2)-SQP(1) 121,741.97 122,295.12 122,839.29

PSO 121,735.47 122,513.91 123,467.40

APSO(1) 121,704.73 122,221.36 122,995.09

ST -HDE 121,698.51 122,304.30 NA

NPSO-LRS 121,664.43 122,209.31 122,981.59

APSO(2) 121,663.52 122,153.67 122,912.39

SOHPSO 121,501.14 121,853.57 122,446.30

BBO 121,479.50 121,512.06 121,688.66

BF 121,423.63 121,814.94 NA

GA–PS–SQP 121,458.00 122,039.00 NA

PS 121,415.14 122,332.65 125,486.29

FA 121,415.05 121,416.57 121,424.56

DS 121,414.6185 121,414.8449 121,418.8120

6. Conclusions

In this paper, a new approach to non-convex ED problems based on the DS has been

presented. Two well-known test systems have been studied and comparisons of the

quality of the solution and performance have been conducted against several of most

recently published ED solution methods. Based on simulation study, it can be seen

that the quality and reliability of the proposed DS was superior compared to other

methods. In future, the proposed DS can be used to solve ED with more practical and

complex constraints including prohibited zones, ramp rate limits and etc.

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ICEAS 1002

Development of Line Following Car using CCD

Camera

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Abstract

A new era of autonomous vehicle or self driving is getting closer to reality in order

to reduce traffic accident and improve mobility system, i.e. traffic efficiency.

Therefore, the development of 1-10 scale prototype based on dynamic line tracking of

a car within a visual environment by an intelligent control is developed. The line

follower car is a mobile machine that can detect and follow the line along the track or

road. This motion control is using visual servoing techniques to reduce computational

overhead. The visual information received are extracted from horizontal line of each

frame and then passed into a proportional steering system. This research paper

demonstrates a prototype development of intelligent line follower control based on the

intensity line profile is analysed using Design of Experimentals (DOE). The

experimental approach to development and testing uses a small scale test track

designed to imitate a real environment. DOE has the ability to discover the presence

of interaction between the variables of the line profile. The discovery of interacting

variables has led to breakthrough improvements in the efficiency of the detecting

intensity of the line on the track.

Keywords: Analogue and Digital, Intelligence Systems, DOE

1. INTRODUCTION

The increasing rate of road accidents has become a major concern in the world

especially during the festive seasons. It believes to have connection with the way we

drive cars and also the rapid growth in population and motorisation encountered by

the country. Therefore, driverless car technology is solutions are being worked out.

Apart from this, the development of autonomous vehicle has been widely used in

various fields like industries, research and development, academic, militaries and

others. In order to make a fully automated driverless car that will use on the highway

or for other applications, research of the development of integration vision data using

small size mobile robot as prototype is coming to a point where the approaches,

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algorithms and models need to be applied for further understanding of their usefulness

and applicability towards any given project for a driverless car [1].

Nowadays, it has far outgrown the capabilities in terms of high end technologies

solutions in the autonomous vehicle. With the fast growing costly development but

yet with economic restraint, need for highly effective and efficient integrated between

autonomous vehicle and details information about the path required intensive research

efforts to create new intelligence algorithm for path following vehicle [2][3].

Particularly, intelligent system synthetically considers all sorts of different path

sections, combining with communication means, transfers the information allocated

rationally, balanced and interacted between vehicle sensors and surrounding

infrastructure, to vehicle device for providing drivers with path to be chosen [5][6].

Therefore, the autonomous driving has become a hot and focus in the intelligent

system. At present, the control theory and control technology, driven by the rapid

development on the information technology and integrated circuit manufacturing

technology, make a significant progress, such as the improved PID algorithm,

adaptive control, neural networks and fuzzy control, robust control, sliding mode

control, optimal control, as well as many other modern control algorithms have been

widely used.

Visual information plays an important role in almost all areas in robotic

applications. Vision sensors such as camera are mainly used for mapping and

obstacles detection and usually object-referenced by other sensors [7][8][9]. For these

reasons, we are focusing on the development in line follower car using

Charge-Coupled Device (CCD) camera as detection sensor. Various techniques of

extracting data from camera are available to meet the requirement of this particular

application, which provides a flexible enhancement to the data collection technique.

The study of visual sensor based on two basic issues. One is to determine on how to

obtain raw data received correspondence from image sequences, and the other is to

optimise collected data and use them as control input.

This development is a subset of the potential application of autonomous car

capabilities but is well quantified. To improve the efficiency of the experiment that is

to reduce or to remove the experimental bias, according to DOE method, it is

suggested to use three basic principles of DOE. They are randomisation, replication

and blocking [10][11].

2. SYSTEM DESCRIPTION

The car is a standard model kit that was used in the Freescale Cup Intelligent Car

Racing competition. The model is equipped with a Futaba steering servo and

MC9S12XS128 microcontroller. The model has been chosen because it gathers

several advantages:

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 light weight and portable: The basic element of the model is very light and

portable that allow us to easily assemble electronic devices and light enough to

be handled at the testing area. The chassis of the model is supplied with the

7.2V battery pack.

 steering servo: The servo motor is the most important part in this model and it is

used to improve the steering. The front wheels are steered by a powerful servo

motor in order to position the model on the track.

 interface software: There are continuing image data input capture from CCD

camera through interface circuits to the microcontroller unit. Important sensory

information such as steering wheel angle and

wheels velocities and car status are directly

accessible. The microcontroller unit will need to

communicate with the camera to follow the path

and speed of the car.

All these features facilitate the process of modifying this

model for autonomous driving. The fully equipped

model is depicted in Fig 1. This mobile robot consists of

two major control modules; speed control module and

direction control module. Both control modules are

responding based to the PWM signal generated by

HCS12 MCU which is Freescale’s

MC9S12XS128 16-bit MCU. PWM value to control direction and speed are

determined by heuristically. The overall system includes a chassis 1-10 scale and one

CCD camera supplied by Axiom and Sparkfun, respectively.

A. Model modification

The model was competed in smart-race competition organize by FreeScale

(Malaysia). Originally the model is a simple chassis and a servo with nothing special

in its functions. In order to enhance the original model kit for autonomous driving,

several modifications have been performed on the model. This section describes the

mechanical and electrical changes that were necessary.

Since the model’s tyres interact directly with the track surface, it will affect directly

the model’s stability and speed [12]. The tyres are provided by the organiser and we

will follow and comply with term and regulation set for competition where

modifications on the tyres are prohibited, we emphasise more to the existing tyre

adjustment.

During the adjustment process, the new tyres after used for some time, will make

the model grasping ability to the track surface increase and then decrease gradually.

This is because after the tyres used for some time, the surface become rough and the

Fig. 1. Model Kit

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central part of the tyre are worn out, thus; the overall tyre’s surface becomes more flat

and grasping ability to the road surface increase. Thus, the tyre configurations are

needed to accurately quantify the effect of wornness during the turn taken at sharp

corner.

Correct alignment of the wheels maximise the ability of vehicle to run straight with

a little steering effort. Adjustments on this parameter are made to enable the model to

move in a straight line on track, increase the stability, enable wheels back to initial

position automatically after turning, and reduce the spare parts’ and tyre wear.

The CCD camera is attached to the mobile robot that acts as a sensor must made

strong requirement such as mechanical robustness, selection angle of the camera for

optimal visual, and dust proofness.

B. Mircocontroller

We re-engineered a standard model car that used for competition to autonomously

navigate through a track. The autonomous car must be able to interpret its

environment by gathering information from the CCD camera. A microcontroller of

16-bit embedded processor may then access communication reading from CCD

camera and the servo motor to determine and control the position of the car. Plus, this

information also is used to adjust the speed as needed. The block diagram of the

overall system as shown in Fig. 2 illustrates the integration vision environment.

The microcontroller unit interfaces with an analogue camera to receive image

through the general purpose I/O port. Then, IC LM1881 is used to extract video sync

from the composite video data so that the microcontroller unit can sample the video

data at the right time.

To allow the car to detect the black line on the track, CCD camera is used to scan

the image and transporting a NTSC signal to microcontroller. Interfacing circui t

between microcontroller and other devices such as camera, servo motor and DC

motor are need to achieve project’s

objectives. Once the CCD camera

receives start command, the onboard

microcontroller initialises a scanning

algorithm and records up in a set of

registers. Thus, the microcontroller

will receive inputs from cameras and

will generate commands to the

system.

Fig. 2. Scope of Work

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By using LM1881 video chips, analogue video signals can be extracted out and the

image signal synchronisation can be identified. By inputting these signals and

analogue video signals to the microcontroller, the right timing of the digital image

information can be collected. Fig. 3 shows the video signal separation circuit

schematic. Therefore, this microcontroller unit can be used to generate the automotive

applications such as a controller for the intelligence car which is same as in this

project.

C. Scanning and track

characteristic

Scanning is the method to break

down the scene into picture

elements and reassembling them

on the screen. It is like human

eye’s motion when reading. The

scene is divided into a series of

horizontal lines during scanning

and this is illustrated in Fig. 4. Camera will start to read the topmost of the horizontal

line from left to right. It will produce a series of analogue signals that based on to the

intensity of lights and shadows along that horizontal line. After finishing each

horizontal line, it will retrace back to the left end of the next line below and follows

process in the same way. By repeating this process, camera will reads the whole area

of the scene, line by line, until to the bottom of the picture. Then the camera will scan

the next image, and process continually repeated. So now, the camera has produced a

rapid sequence of analogue impulses

which is corresponding to the order of

every picture lines for all images that

had been captured. This visual

technique is used in order to detect the

line and follow it by using image

processing for interpretation.

The experimental track setup of the

line follower car is depicted in Fig. 5.

The mechanism design in the steer of

the car is according to Ackerman

principle. Thus, this principle provides

the car to rotate and the wheels roll smoothly along the single transformation centre in

order to stay on the test track. The track was made from three centimetre wide curves

cut from white and secured to the field surface with black colour masking tape. The

Fig. 3. Video Signal Separation Circuit Schematic

Fig. 4. The Principle of Scanning

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masking tape on the paper provided high contrast path, which was easy to distinguish

by thresholding of the image.

Using this track allowed us to obtain image information from CCD camera. Then

process the information, calculates corresponding to control input and sends these

back to the servo motor. Line follower car are dynamically unstable and require

constant control input to prevent it from diverging from the test track. The main

concern in any navigation system is safety. While car runs on the track, following car

conditions have to be met:

CC1 Stay on the track and running smoothly; It is vital for the car to stay on

its track to avoid any accident occurs.

CC2 Speed and break based on track conditions; If the car moves too fast, it

will lose its grip on the track and thus will out of control and if the car moves

too slow, more time is needed to reach the destination it will waste the time.

Following are the track conditions:

TC1 As shown in Fig. 5(a), the

surface of the track is a white

base plate with a continuous

black line. The width of the

track is 60cm while the width

of the black line is 2.5cm. The

black line is at the center of

the track.

TC2 The minimum bending radius

of the track is 50cm. As shown

in Fig. 5(b), the condition is

applied in every curve in the

track.

TC3 Referring to Fig. 5(c), the

track can be cross line with

angle of 90◦.

TC4 There is an up-slope and down-slope on the track. According to Fig. 5(d), the

maximum angle of the slope is 15° where slope will be in a straight section of

the track.

The track is designed to have several challenging areas for the line follower car,

including the hill climb, uneven surface (rattle track), S-conners, and sharp turn after a

relatively long straight section where the car builds up speed.

3. THE TRACKING ANALYSIS VIA IMAGE SIGNALS

Fig. 5. (a) Surface of the track is white base plate

with continuous black line. (b) The bending

radius of the track should not be less than 50cm.

(c) The track can intersect with a crossing angle

of 90◦. (d) The slope is placed in straight line

section.

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The car uses the CCD camera as an image sensor to trace the racing track. The

image sensor produces the NTSC standard analogue video signals. The A/D converter

of the S128 MCU is used, and with corresponding to the sub video signal produced by

the original signal, image signal can be collected within the RAM of the

microcontroller. By going through the algorithm software for image signal processing,

the actual path of the black line can be known.

Analogue signal output from the CCD camera is a NTSC standard signal where

horizontal scanning frequency is about 15.734kHz and vertical scanning frequency is

59.94Hz. Odd field scans first and then followed by even field to complete one cycle

field which means that if scanning frequency of odd field and even field is

approximately 30Hz, then the scanning frequency for one field is 59.94Hz.

By referring the NTSC standard specification on National Instrument datasheet,

scanning period can be calculated by

(1)

where is the fundamental frequency and is the fundamental period of a cycle.

As expressed by Eq. 1, cycle period is the reciprocal of frequency. That is, the product

of frequency or number of cycle per second and the cycle period equals one second. It

is important to note that for analogue standard colour NTSC, the line frequency for

horizontal line rate is 15,734 line per second and by using Eq. 1 we obtain

However, based on NTSC specification on video format, active line duration for

NTSC format is only . For now, all calculation for data sampling will be

used active line duration which is . And vertical scanning period is

By using LM1881 video sync separator, the odd even field can be identified by the

microcontroller through the detection of logic 1 or 0 of digital I/O. Using A/D

convertor of the microcontroller, the NSTC signal from the camera is converted to

digital format. The complete A/D process need 14 cycles. In order to sample more

data from the NTSC signal, phase-locked loop (PLL) circuit is used to boost up the

A/D conversion clock. The setting of the PLL module is adjusted to boost the bus

clock frequency from 8MHz to 10MHz. From that signal, a locking range in Voltage

Controlled Oscillator, , and a reference clock, , as well as bus frequency,

, are calculated [13] as follows

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(2)

(3)

(4)

Number of data sampling A/D is performed through Eqs. (2),(3) and (4). The

frequencies in units of MHz are picked from the frequency list-box [13]. The

frequencies are wrote synthesizer register (SYNR) that initialises into the lock

detector bit with PLL and Bus sample rate of 64MHZ and 32MHz, respectively. The

A/D conversion time of the measurement signal can be defined as

(5)

In the calculation, the relative total number of sample data of a particular image

with respect to one horizontal scanning means the A/D of S12XS MCU can be

sampled around 119 data. After determining the number of sample data, the program

started by initialising the PLL module and also the PWM channels. After that, the

program will wait for the first vertical sync of the video data before entering an

infinite loop. The program will always acquire the video data from an odd field. There

are 262.5 video lines per field. The program will enter a nested ‘for’ loop to count the

number of video lines gone through until there are 240 lines, which means a complete

odd field has been scanned. The video data are the input from AN00, which are stored

in a one-dimensional array, namely Cdata[118].

At the even field, data store in array elements is accessed to determine the track

position. Then, the relative position of the centre point in the array is calculated. The

relative position will be used to calculate the new PWM value to control the car

steering. After that, the new PWM value to control the car speed will be determined.

The system will wait for the odd field of the next frame to sample the new video

data again. The process of getting video data and calculate the new PWM value will

go on as it is an infinite loop.

CCD camera is used to identify the pattern of the track. Since signal of the camera

changes rapidly, the signal is needed to be stimulated separately. The IC LM1881

circuit is therefore being designed where it is used to extract odd/even field

information of the camera. LM1881 also allows the output from the CCD camera to

be collected in a normal timing. Based on the analysis of the data for the A/D of

Table 1

Determination of Centre Point

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MC9S12XS128 using BDM from the Code Warrior development tool, it is clearly that

the value of the dark line varies with the changes of the surrounding. For example, if

the data of the dark line are collected in a darker area, the value in the MC9S12XS128

will be around 43. If the data is collected in a bright area, the value in the

MC9S12XS128 will be around 75.

Therefore, to allow MC9S12XS128 to differentiate the dark line efficiently

regardless of the surrounding conditions, the threshold value is being determined each

time after the data from the camera is being collected by using Eq. 6. Values l ower

than the threshold is considered as the dark line. The threshold value is determined by

(6)

where is the threshold limit value, the constant value, is the minimum

value data and is the maximum value data from one-dimensional array.

The constant value must be smaller than 0.5 and it is set at 0.5. The system will

store single horizontal scan line data input in one-dimensional array which is named

as Cdata in this project and this data is stored in digital value. Fig. 6 shows part of the

video data stored in one-dimensional array Cdata [118] where the Analogue to Digital

(ATD) value of video line can be seen when it is expanded. The value is subjected to

change depending on the threshold and brightness of the area covering the track.

4. EXPERIMENTAL AND DISCUSSION

The goal of calculation using the methods of finding minimum and maximum

value in a one-dimensional problem of sites is to find the threshold values of point set

when the image processing unit configured the output of image data supplied. In this

work, the system will search and store the minimum and maximum value within the

input range. For instance, in one horizontal line scanning, we can determine the

maximum ATD value is 75 and the minimum value is 42 (refer Table I). Thus, by

using Eq. 6, the threshold value of this system is 59. This value will be compared to

each of the input values. When ATD value is lower than the threshold value, the

system will consider as a black surface or black line. At this particular line, P5 and P6

are lower than the threshold value, it considers as black lines. So, the system can

detect bright-to-dark transitions (P5) as well as dark-to-bright transitions (P6). Centre

point of black line can be determined by using

(7)

Based on Eq. 7, the centre point is P6. Calculation in this system is in an integer value

and the centre point value is 5.5. Thus, system will consider black line at P6. P6 is

slightly close to P7 which is not the black line anymore. As a result, value for PWM

will affect as well as servo motor that turning the front wheel. In the case of number

of black detected increase, error in the system will be reduced. So, to reduce error in

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the system, Design of Experiment (DOE) is used to determine highest black line can

be detected.

There are three major factors that can be considered as a factor to the number of

black lines, , detected; the delay time after 1 data store in C data [118], horizontal

line that system take from camera

image, and angle of the camera to

take an image. All data collected

and all analysis has been done by

using Minitab software.

In Analysis of Variance

(ANOVA), the hypothesis as follows

(8)

(9)

where the subscripts and represent two different population called treatment.

The null hypothesis, , and alternative hypothesis, . The null hypothesis is

assumed all factors have same number of black detected. Alternative hypothesis

where there has some variation of mean on the number of black detected. The Eqs. (8)

and (9) have to satisfy the rejection condition of if . The value is

computed using Eq. (10).

It is clearly shows that at Table II, -value are less than 0.05 for each of the factors

that use in this evaluation. Hence, is rejected and it can conclude that the

treatment means differ; that is, the delay,

angle and line setting significantly affect

the meaning of black detected. The

interaction between delay and angle is also

a significant ( -value < 0.05) and other

interaction is not significant.

Based on Fig. 7, for the delay factor, it

can show clearly that there is extremely

different from delay 0 and delay 1

compared to others level in same factor.

However, based on this figure only,

conclusions cannot be made either the difference is significant or not. Therefore, it

needs to compare each mean value using Tukey’s test to show the difference between

levels.

Here an example of Tukey’s test for Delay factor. The - value of delay factor is:

Fig. 6. Part of Video Data Stored in

One-dimensional array

Table II

ANOVA For Each Factors

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(10)

where value from attached studentized range table, , mean square error from

ANOVA table, , the upper percentage of point , the number of degrees of

freedom associated with the , , and number of replicates per treatment, . To

use a fix significance level approach, we select is 0.05 and is 245 degrees of

freedom error. By using Table Percentage Points of the Studentized range [14] gives

-value is 2.2022. This value needs to compare with every difference between levels

in delay factor. Any pairs of treatment averages that differ in absolute value by more

than 2.2022 would imply that the corresponding pairs are significantly different.

Again, on Table II, there are factors that having an interaction that affects the number

of black detected, they are angle and delay factors. The contour levels are plotted in

the curves and the area between the curves is coloured to indicate interpolated values.

Based on three contour plots

calculated using DOE analysis, the

best setting of the camera to capture

an image is when 0 delay, 30 angle

and line 240.

A. Pre-run Image Scanning on Track

Fig. 8 shows the video data that are stored in a one-dimensional array Cdata [118],

where the data of video line can be seen by expanding the row. When Cdata is

expanded, the values in the array of size 118 are shown. The array element number is

getting bigger as the video line goes from left to right. The array elements with 11 of

the numbers from leftmost do not take into consideration. This is because there is

front porch of a video line respectively.

A range of white pixel is and for black pixel is

. The black pixel is within array element number 55 to 76 (refer to

Fig. 6). By comparing the threshold value and calculation of centre point of the black

line detected, it is shown that the next condition of the track is in a straight line. PWM

value to the servo motor should also be changed so that the car can steer towards the

position.

5. CONCLUSION

Fig. 7. Main Effect Plot

Fig. 8. One-dimensional Array Data

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In this project, the car is successfully run on the track and finishes the line. The

proposed system of autonomous car using video processing to follow the black line on

the track has been presented. Two modules and several techniques applied based on

vision sensor have been shown that the system will react based on continuity input

image data through interface circuits to the microcontroller to store in

one-dimensional array (Cdata [118]). The system consists of two major control

modules which is speed control module and direction control module. Both control

modules are responding based to the PWM signal generated by HCS12 MCU which is

Freescale’s MC9S12XS128 MCU.

However, the limitation on this system where the system does not have any

feedback for speed control module. It is an open-loop control system. There is a

possibility that output speed is not linear with the PWM that generated by the MCU.

If there is no linearity between car model speed and the PWM duty cycle, the stability

of the car will be affected.

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ICEAS 1038

Difference Grey Sliding-Mode Control of a UPS Inverter for Robust

Output Voltage Tracking

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Abstract

In this paper, a sliding-mode control (SMC) with difference grey prediction is

proposed and applied to UPS inverters. Though the SMC is insensitive to system

uncertainties within expected limits, the chattering and steady-state errors may occur

when uncertainty values are overestimated or underestimated. The chattering and

steady-state errors will cause inexact tracking control, and even deteriorate the system

performance. Thus, to alleviate the chattering and steady-state errors, a

mathematically simple and computationally fast difference grey prediction is

employed for SMC and therefore low distorted voltage in UPS inverter output can be

obtained. Experimental results for the UPS inverters are performed in support of the

proposed method.

Keyword: Sliding-mode control (SMC), Difference grey prediction, UPS inverters,

Chattering, Steady-state errors

1. Introduction

The limitation of low distortion in the output voltage of the uninterruptible power

supplies (UPS) and fast dynamic response when feeding distorting loads are the

challenging issues, which have stimulated the development of a variety of different

methods. Control of UPS inverter is a tracking control problem, which achieves a

sinusoidal AC output voltage tracking and minimizes the total harmonic distortion in

the presence of disturbances and plant parameter variations. Conventionally, when the

system has external load variations and other disturbances, a PI controller is used in

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the UPS inverter for the improvement of the system operating characteristics.

However, the PI controller can not overcome the sensitiveness for system parameters

variation [1], [2]. Thus, to avoid the system uncertainties, robust nonlinear control

strategy can be used, i.e., sliding-mode control (SMC). Essentially, the SMC utilizes a

high speed switching control law to force the state trajectory of the plant which is held

in the sliding surface and then the state trajectory was along this surface to the origin

[3], [4]. Consequently, the expected control target to the nonlinear system can be

attained by the selection of the appropriate sliding surface. The benefits of SMC are

insensitive to the parameter variations of the plant and the external disturbances.

However, in the SMC, the upper/lower bound of the system uncertainties is supposed

as the maximum/minimum value. The chattering and steady-state errors may occur . In

order to overcome the chattering and steady-state errors, previous works have used

adaptive or observer controllers to estimate the bound of the external load disturbance

by complex mathematical models or complex calculation [5], [6]. The grey theory has

been proposed by Deng., and many applications in a variety of fields have been

developed [7], [8]. The grey model is built based on first-order differential equation,

and used some hypothesis and mathematical approximation to transfer a continuous

form into discrete form. Such a transformation will confront some unconquerable

problems, such as the limited sampling frequency, sample/hold effects and

discretization errors. Using difference equation replaces differential equation to build

grey model that is a reasonable and precise method [9]. This paper employs a

mathematically simple and computationally efficient difference grey prediction to

alleviate the chattering/ steady-state errors when the upper/lower of the system

uncertainties is overestimated/ underestimated. The grey prediction requires only

several output data to achieve a grey model and to forecast a future value without

complex calculation. Thus, the proposed method will yield a closed-loop UPS inverter

with low THD, fast dynamic response, chattering elimination, and steady-state errors

reduction under different types of load. The organization of this paper is as follows:

Section 2 describes the mathematical modeling of the UPS inverter. The proposed

SMC with difference grey prediction is designed in Section 3. Section 4 shows the

experimental results. Section 5 concludes the paper.

2. Mathematical Modeling of UPS Inverter

A single-phase UPS inverter is shown in Fig. 1, consists of a LC filter and a load

resistance. The LC filter and the load can be considered as the plant of a control loop.

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V

d Load

L

C

PWM Inverter Output Filter

1

T

3

T

2

T

4

T

i

L

i

C

i

O

v

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+

-v

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-Fig. 1 UPS inverter with LC filter

Fig. 2 shows the block diagram of the LC filter. Thus, the state space equation of

the LC filter can be represented in the following state space form.

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-Fig. 2 The block diagram of the LC filter

We use the state vector

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to replace of the state vector

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, and the state

space form is rewritten as follows.

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C

v

LC

v

v

LC

v

v



  

 1

1

0

1

0

0

1

0 1

(2)

From Fig. 2, the output voltage,

c o

v v 

is expected to track a sinusoidal ac voltage,

ref

v

. If the output voltage,

O

v

tracks a reference voltage,

ref

v

strictly, the difference

measure, between

o

v

and

ref

v

can be converged to zero. Thereby, define

O ref

v v e  

1

and

1 2

e e  

. Then, the error dynamic state space equation is derived as

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f

u

b e

e

a a e

e 0 0 1 0

2

1

1 2 2

1





(3)

where

L

K K

a

PWM C



1

,

LC

a

1

2



,

LC

K K

b

PWM C



,

   d f

,

O

i

C

d



1



,

ref ref ref

v v a v a       

2 1

.

3. Control Design

3.1 Sliding-mode control

The sliding surface,



is selected as

2 1 1

e e c   

(4)

where

1

c

is constant.

As a consequence of (4), it is also

2 1 1

e e c      

(5)

Substituting the system state equation (3) into (5), we have

134

f bu e a e a e c e e c       

2 1 1 2 2 1 2 1 1

   

(6)

Let

2 , 1 ,

0     i a a a

i i i

,

b b b   

0

.

where

0 i

a

and

0

b

are nominal values of

i

a

and

0

b

, and

i

a 

and

b 

are the

deviations, respectively.

Then, decompose the control function, u into

s eq

u u u  

(7)

where

eq

u

, called the equivalent control, is used to control the overall behavior of the

system. The equivalent control is defined as follow:

0

0 , , , , 0 20 2 10 1



     O eq

i b b a a a a u u

 

(8)

When in sliding motion, let

0  

, then

1 1 2

e c e  

(9)

0

10 20 2

2

1 1 10 1 1 20

b

v v a v a e c e a c e a

u

ref ref ref

eq

        

 

(10)

The

s

u

is used to suppress the parameter variations. This function is constructed in

the following:

3 2 2 1 1       e e u

s

(11)

The condition for the existence of sliding motion is

0    

(12)

Substituting (10) and (11) into (12), one has



 0 )

( 1

) (

1 ) (

-

)

( 1

3 10

20

0

1 2

2 2 1 1 1 1 20

0

0

10 1

2

1 1 2

1 2

3 2 2 1 1

10 20 1

2

1 1 10 1

1 20

0

2 1 1 2 2 1

1 2

0 2 1 1 2 2 1

     

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      

 



 

 

b d v v a

v a

b

b

v a v a

e b a c e b a

b

b

b

b

a c c e a

v v a v a

d e b e b

v v a v a e c e a c

e a

b

b

e a e a e c

v v a v a d

bu bu u b e a e a e c

ref ref

ref ref ref

ref ref ref

ref ref ref

ref ref ref

s eq eq

u u u

s eq

  



  

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  



(13)

Thus,

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0 if

1 ) ( sup

0 if

1 ) ( inf

1 20

0

0

10 1

2

1 1 2 1

1 20

0

0

10 1

2

1 1 2 1

1







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e b a

b

b

b

b

a c c e a

e b a

b

b

b

b

a c c e a

(14)

135

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1 1 2

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b c a

(15)

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0 if )

( sup

0 if )

( inf

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20

0

1 2 3

10

20

0

1 2 3

3



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



b d v v a

v a

b

b

v a v a

b d v v a

v a

b

b

v a v a

ref ref

ref ref ref

ref ref

ref ref ref

  

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

(16)

where the symbols inf and sup denote infimum and supremum, respectively.

3.2 Difference Grey Prediction

The basic idea of the grey system is to establish an approximation model of the

unknown or partially known system. By the accumulated generating operation (AGO)

and according to the measurable original data, the grey modeling procedure can be

described as follows:

Step 1: Gather the original sample data sequence

  n k k x x ..., , 2 , 1 , ) (

) 0 ( ) 0 (

 

. (17)

Step 2: Mapping generating operation (MGO)

The data sequence of the system may be positive or negative. We use the MGO

to map the negative data to the relative positive data.

  n k bias k x xnew

..., , 2 , 1 , ) (

) 0 ( ) 0 (

  

(18)

where bias is constant.

Step 3: Take Accumulated generating operation (AGO) for

) 0 (

new

x

n k i x k x

k

i

new new

..., , 2 , 1 , ) ( ) (

1

) 0 ( ) 1 (

  



. (19)

Step 4: Construct the difference equation model

The linear difference equation grey prediction model is established as

0 ) ( ) 1 ( ) 2 (

) 1 ( ) 1 ( ) 1 (

     k Nx k Mx k x new new new

(20)

where

M

and

N

are the coefficients of the difference equation grey prediction

model that needs to estimate their values.

The (20) is rewritten as the following matrix form

    ) 2 ( ) ( ) 1 (

) 1 ( ) 1 ( ) 1 (

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   k x

N

M

k x k x new new new

. (21)

Let

2 ..., , 2 , 1   n k

and (21) will be

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) (

) 4 (

) 3 (

) 2 ( ) 1 (

) 2 ( ) 3 (

) 1 ( ) 2 (

) 1 (

) 1 (

) 1 (

) 1 ( ) 1 (

) 1 ( ) 1 (

) 1 ( ) 1 (

n x

x

x

N

M

n x n x

x x

x x

new

new

new

new new

new new

new new

  

. (22)

Suppose

136

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) (

) 4 (

) 3 (

) 1 (

) 1 (

) 1 (

n x

x

x

Y

new

new

new

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

) 2 ( ) 1 (

) 2 ( ) 3 (

) 1 ( ) 2 (

) 1 ( ) 1 (

) 1 ( ) 1 (

) 1 ( ) 1 (

n x n x

x x

x x

B

new new

new new

new new

 

,



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 

N

M

.

The estimated parameters

M

and

N

can be solved by the least square estimation

method.

  Y B B B N M

T T T 1

) ( ,



  

. (23)

Next, we need to find the solution of (22).

Let

k

new

k x   ) (

) 1 (

,

1 ) 1 (

) 1 (



 

k

new

k x 

, and

2 ) 1 (

) 2 (



 

k

new

k x 

, the following equation can be

obtained:

0 ) (

2 1 2

     

  N M N M

k k k k

     

(24)

The roots to satisfy (24) are given as

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2

4

2

4

2

2

2

1

N M M

N M M





. (25)

Therefore, there are three cases for (25) as follows:

2 1

  

; 2)

2 1

  

; 3)

1



and

2



are complex conjugate.

Step 5: Take Inverse accumulated generating operation (IAGO)

) 1 ( ˆ ) ( ˆ ) ( ˆ

) 1 ( ) 1 ( ) 0 (

   k x k x k x new new new

(26)

Step 6: Inverse mapping generating operation (IMGO)

Applying IMGO for

) 0 (

ˆ

new

x

, the predicted value of the original data sequence

) 0 (

ˆ x

is obtained as

bias k x k x k x new new      ) ( ˆ ) 1 ( ˆ ) 1 ( ˆ

) 1 ( ) 1 ( ) 0 (

(27)

3.3 The Combination of Sliding-mode control and Difference Grey Prediction

Because the upper/lower bound of the system uncertainties is supposed as the

maximum/minimum value, the system loses robustness and causes the chattering and

steady-state errors in the SMC. To alleviate the chattering and steady-state errors, a

sliding-mode control with difference grey prediction is derived.

The classic control input,

) (t u

is redefined as

dgy s eq

u u u u   

(28)

where

eq

u

is the equivalent control,

s

u

is used to alleviate the influence due the

plant parameter variations, and

dgy

u

offers the compensation with difference grey

prediction due to the external disturbances.

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 

 

ˆ ,

ˆ ,

) ˆ sgn(

ˆ

ˆ

0

2

b

u

dgy

(29)

where “^” denotes the forecast value with grey prediction,

2



is a constant, and



is

the system boundary. Thus, if (29) is employed as this proposed method control input,

the system is asymptotically stable.

Proof: The Lyapunov function is defined as

137

2

2

1

  V

(30)

Differentiating V with respect to time yields

0

) ( ) ˆ sgn(

ˆ

ˆ

) sgn(

2 1









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    



d bu

b b

V

 

 







  



(31)

where

1



is a constant. Therefore, the dynamic system is asymptotically stable.

4. Experimental results

The system parameters of UPS inverter are listed as follows: Vd

=250 V; v

o

=110

Vrms

; switching frequency=18 kHz; L=1 mH; C=30 μF; rated load R=10 Ω. Figure 3

shows the output voltage and the load current obtained using the proposed method at a

full resistive load and Fig. 4 shows that obtained using the classic SMC at the same

load condition. These output voltages are nearly sinusoidal with negligible distortion.

Figure 5 and Fig. 6 show the output voltage and the load current obtained using the

proposed method and the classic SMC under step load change from no load to full

load, respectively. Inspection of the waveforms indicates a smaller voltage dip in Fig.

5, as compared with Fig. 6. It is obvious that the proposed method has better

robustness when an external disturbance is suddenly applied to UPS inverter. Table 1

gives the percentage of THD under these testing conditions. From Fig. 5 and Table 1,

we observe that the proposed method can compensate inverter output-voltage dip very

quickly, and the percentage of THD when the load sudden change is lower than the

classic SMC. It is very clear that the proposed method is successful to alleviate the

chattering and steady-state errors, thus yielding robust system performance.

Fig. 3 Output voltage with resistive load (R=10Ω) for proposed method

Fig. 4 Output voltage with resistive load (R=10Ω) for classic SMC

Fig. 5 Output voltage with sudden step load from ∞Ω to 10Ω for proposed method

v

o,

100V/div

i

o,

10A/div

0

5ms/div

v

o,

100V/div

i

o,

10A/div

0

5ms/div

v

o,

100V/div

5ms/div

i

o,

10A/div

0

138

Fig. 6 Output voltage with sudden step load from ∞Ω to 10Ω for classic SMC

1.1.1. Table 1 Output voltage %THD

Proposed method Classic SMC

Resistive Load 10Ω 10Ω

%THD 0.32% 0.71%

Step load change From ∞Ω to 10Ω From ∞Ω to 10Ω

%THD 2.61% 7.43%

5. Conclusions

In this paper, a difference grey prediction compensated sliding-mode

controller is applied to the UPS inverter. The upper/lower bound of system

uncertainties do not require high accuracy by difference grey prediction. Thus,

grey prediction alleviates the chattering and steady-state errors, which exist in

classic SMC system. The experimental results verify that the proposed method

can obtain high-quality and high-accuracy AC voltage and low THD in the UPS

inverter output.

6. Acknowledgement

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v

o,

100V/div

0

5ms/div

i

o,

10A/div

139

EECS 391

A FPGA-based Space Vector Controller With Power Stage

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Abstract

This paper will introduce a FPGA-based space vector controller with communication

interface and power space designed for educational purposes. Frequency inverters

employing space vector controllers are usually complex and interdisciplinary devices

which are difficult to cover completely in one semester. They require the knowledge

of electrical machines, power electronics and control theory. In this paper a different

approach is proposed based on methods derived form information technology. Using

programmable devices in conjunction with a communication interface it is possible to

depict a space vector controller as a software entity which can be described

accordingly. The paper will describe the application topology, methods used and the

results obtained so far.

Keywords: space vector controller, FPGA, I2C-interface, VHDL

1. Introduction

Many frequency inverters use space vector based algorithms to control their power

stages in order to drive the attached induction or synchronous motors. They also

include elaborate methods to identify the attached machines. In order to familiarise

students with the workings of a modern frequency inverter the complex system has to

be stripped down to its essential components. These are the space vector controller

and the power stage. Machine identification is an add-on which can be explained in

sufficient detail separately and the closed loop control algorithm for the frequency

inverter is of only secondary interest in this context.

The focus therefore is on an easy to understand and handle implementation of a space

vector controller. The power stage will be added later on to verify the theoretical

results. Also a means of measuring the workings of the controller has to be established.

All this should be accomplished using a minimal hardware configuration, preferably

based on a laptop computer or PC.

2. Development environment

As the basis for the development environment tools have been selected in such a

way, that every development step can be executed using a standard laptop

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computer. All tools are provided with a free software licence. The complete

environment can therefore be used by students not just in the classroom but

anywhere without additional license fees.

The environment consists of a FPGA development suite, in this case Xilinx

based [1], software for communicating with an I2C-interfac, which later on

establishes communication with the space vector controller and software for a

PC based oscilloscope to monitor the controller output (Fig. 1).

In this scenario the FPGA is host to the space vector algorithm. It is configured

via the USB interface using the laptop computer. No information is fed back by

the FPGA directly to the computer once the space vector has been implemented.

The I2C-interface is used to communicate with the space vector controller and

represents higher level control components from the controller point of view. All

parameters and data are exchanged via the I2C-interface. The oscilloscope

represents an external observer of the system monitoring the control signals for

driving the power electronics.

Oscilloscope, I2C-interface and FPGA board are actual hardware components

attached to the computer via a USB interface. They are not required for the actual

development process of the space vector controller.

2.1 I2C-Interface

Frequency inverters and other power electronics related equipment are usually

controlled via various bus systems like PROFIBUS [2] or industrial Ethernet.

They require a complex protocol to be handled by the devices attached to the bus

which adds a further layer of complexity. In this case, in order to keep things

simple and transparent, the I2C-bus was chosen as a means to communicate with

the controller. Since no protocol has to be implemented, parameters can be

transmitted to and read from the controller directly. Students can therefore

laptop

I2C-interface

FPGA

oscilloscope

USB

USB

USB

I2C

measurements

Fig. 1: Development environment

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observe immediately the effects of single bytes of information sent. As a

disadvantage it has to be noted that the I2C-interface has to be implemented on

the FPGA besides the space vector controller too. This makes the design process

of the FPGA more complex. Practical results however have shown, that the

I2C-Interface can be separated form the space vector controller quite neatly and

can thus be treated as a black box which just provides parameters or stores data.

Since the I2C-interface is not the main focus of this work, a concise example of

its workings will be given only to demonstrate its advantages (Fig. 2).

The I2C-interface requires only two lines called clock (SCL) and data (SDA) [3].

At first the slave address is sent via the bus by the master, in this case the PC. It

consists of eight bits after which the slave sends an acknowledge (A). After

receiving the acknowledge from the slave the master continues sending data

bytes to the slave addressed until no acknowledge (N) is send by the slave. After

that the transmission ends. No further protocol handling is required and the bytes

sent to the slave directly correspond with actions to be executed by the slave.

The first byte sent represents the slave address, the second byte addresses a 16

bit register of the space vector controller. The values of several registers

determine the behaviour of the controller. The controller can thus be influenced

by simply changing the values of its associated registers (Fig. 3). The bus layer

of the I2C-interface and the application layer of the space vector controller are

clearly separated and in theory the controller would be able to work as a stand

alone device provided the proper initial values are stored in its registers. So in

theory the functionality of the controller could even be demonstrated to students

without an I2C-interface present.

Fig. 2: I2C-interface operation

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3. Application topology

The principal workings of a space vector controller are widely know and will

therefore be only touched upon with regards to the implementation specific points [4].

The theory is based on a continuously moving vector where vector length and speed

can be adjusted in a quasi continuous manner. For the implementation as a digital

system certain limitations apply depending on the platform used. With the FPGA

based implementation mathematically complex operations like divisions and

sinus-functions have to be ruled out, since they are to complex and time consuming to

implement. Therefore the vector can not be depicted as a quasi continuously moving

entity but rather like an entity which can only assume a limited number of positions in

the complex number plane (Fig. 4).

The number of possible positions Pn

depends on the binary representations of the

I2C bus

serial

bit

conversion

write register

read register

address

logic

data exchange

application

registers

0

n

n+1

application layer

bus layer

Fig. 3. I2C interface

Z1

u

1

 Z2

Z3

Z4

Z5

Z6

Z7

Re

Im

P

n

P

n+i

u

1max

Fig. 4. Possible position in the complex number plane

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possible controller values. In this case, 127 positions Pn

have been sampled per 90

degrees at a resolution of eight bits. That results in 255 different vector lengths and a

total of 502 positions per 360 degrees. In other words, 128010 different space vector

positions are possible. The sample values are implemented via a look up table which

is initialised at start-up time.

The space vector algorithm has further been simplified by implementing a single

phase version and phase shifting that version 120 and 240 degrees to generate the

required three phased system. The pulses obtained for a single phase system are

shown in Fig. 5 and the implemented topology in Fig. 6.

At the start of each PWM interval a synchronisation pulse is generated in order to

synchronise the three phases. Please note that in Fig. 5 in order to simplify matters

only 8 sample values at a resolution of eight bits have been used to generate a vector

rotation of 360 degrees. That would result in only 2040 possible positions. It should

also be noted that the smallest circle obtainable with a length of only one is of no

t

u(t)

uPWM

(t)

start PWM interval (sync)

Fig. 5. Single phase voltage and digital equivalent

clock divider

clock divider

counter generator

sin PWM generator

PWM generator

FPGA clock

clock out

sync

Phase 1

index

PWM length

PWM 1

Fig. 6. Block diagram of a single phased sinusoidal PWM generator

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practical value since the output voltage would be of purely rectangular shape.

The block diagram in Fig. 6 is implemented three times on the FPGA, once for each

phase.

3.1 Application implementation

The space vector controller is implemented of an FPGA board running at a 50MHz

clock. The fastest space vector speed f

S

at maximum resolution can be calculated

according to Eq. 1.

Hz

MHz

f

S

390

255 \* 502

50

 

(1)

That of course is to fast for ordinary electrical drives. Therefore the first clock divider

in Fig. 6 can be used to slow down the base frequency f

B

of the system according to

Eq. 2. Please note that N in Eq. 2 will always be an integer number ranging from 1 to

65535, the largest 16 bit number possible.

(2)

As a result only vector speeds of 390Hz over N are possible. That of course results in

significant gaps in the speed spectrum of the attached drive. To minimise these gaps,

sample values can be skipped or repeated in order to influence the vector speed. This

will result in distortions of the generated output voltages and additional losses in the

form of higher harmonics.

Fig. 7 shows a simple example of the switching pulses generated if an operation mode

called half bridge mode.

In so called half bridge mode two times three control signals are generated. Within

Fig. 7. Three phases in a half-bridge mode, angle increment set to 30 degrees

N

MHz

f

B

50



145

each set the signals are phase shifted 120 degrees and the two sets are phase shifted

180 degrees to each other. Of the six signals generated Fig. 7 shows only three.

In full bridge mode only three control signals are generated. They are phase shifted

120 degrees and can be used to control a three phased inverter. Fig. 8 shows an

example of these control signals.

In full bridge mode each signal is repeated basically every 180 degrees, every second

time it is inverted however. Again all three signals are phase shifted by 120 degrees.

5. Conclusion and outlook

The introduced concept was designed to familiarise students with the principle

concept of space vector control. The approach taken was from a point of view which

heavily relied on the concepts taught during informatics sessions. In that view, space

vector control is just another application and not something specific to power

electronics or electrical drives.

The approach proved to be increasing the understanding of students with regards to

the application of space vector control. It also showed to them the close connection of

informatics and control algorithms in current technology. It also enabled students

from other areas of engineering, especially mechatronics, to approach the subject

matter in a standardised way using familiar concepts.

The concept is basically scalable, meaning that an approach using only software

components can be used and extended gradually by introducing various hardware

components such as bus-interfaces, oscilloscopes and finally power stages. Also the

use of software which relies of a cost free licensing scheme proved to be of great

Fig. 8. Three phases in full-bridge mode

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advantage, enabling the distribution of the software via virtual machines to everyone

interested.

The final step of designing an easy to use and robust power stage is already on the

way and will hopefully be concluded in the near future enabling students to observe

not just the switching pulses generated but also voltages and currents in real world

applications.

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EECS 438

Performance of Grid-Connected Hybrid Photovoltaic/Fuel

Cell/Battery Distributed Generation System

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Abstract

In this paper, the performance of grid-connected hybrid distributed generations

isstudied. The hybrid system includes Photovoltaic (PV) panels, Fuel Cells (FC) and

Battery Energy Storage System (BESS).The PV module operates at maximum power

of 20kW regardless of the environmental conditions using P&O MPPT control

method. The FC model provides a maximum power of 40kW using a current

controlled DC/DC boost converter. The BESS consists of a battery, a bidirectional

DC/DC converter and a controller. The BESS is responsible for smoothing and

regulating the DC voltage bus at 400Vduring off-grid mode by charging/discharging

the battery.A PQ-controlled bidirectional PWM inverter connects the hybrid

generations to the grid.The adopted control methods show good performance of the

micro-grid at transient and steady state operations in terms of the quality of the DC

and AC bus voltages.

Keywords: Photovoltaic, Fuel Cell, Battery, DC Micro-grid, Converters.

1. Introduction

Distributed energy resources including distributed generation (DG) with distributed

energy are sources of energy located near local loads and can providea variety of

benefits including improved reliability, self-healing and load control if properly

operated in theelectrical distribution system. Micro-grids are systems that have at least

one distributed energyresource, associated loads, and can form intentional islands in

the electrical distributionsystems. Numerous benefits arise from thisability to island

for events like faults and voltage sags.Smart islanding can greatly enhances the value

propositionfor the utility and the customer. Within micro-grids, energy sources can be

disconnected and reconnectedto electric power system with minimal disruption to the

local loads [1]. DG technologies typicallyinclude photovoltaic (PV), wind, fuel cells,

micro-turbines,and reciprocating internal combustion engines with generators.Most of

the DGtechnologies require a power electronics interface in order toconvert the

energy into grid-compatible AC power. Theoutput of the main inverter should be

compatible in voltage and frequency with themain grid.Different DC/DC converters

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are used for regulating the voltage at the main DC bus to which DC loads are

connected.

DC micro-grids appears recently due to the development anddeployment of renewable

DC power sources and their inherentadvantage for DC loads in commercial, industrial

andresidential applications. The DC micro-grids have beenproposed [2-4]. However,

AC sources have to be convertedinto DC before connected to a DC micro-grid and

DC/ACinverters are required for conventional AC loads.Multiple reverse conversions

in an individual AC or DCgrid reduce the efficiency of power utilization and increase

thecomplexity and cost of equipment due to the embeddedAC/DC and AC/DC

converters.

2. Micro-Grid Configuration and Modeling

2.1 DC Micro-Grid System Structure

The studied hybrid DG system, wherevarious DC sources and loads are connected to

the DC buswhilethe main grid and AC loads are connected to AC bus, is shown in Fig.

1. The DC and ACbuses are connectedtogether through a bidirectional three-phase

6-pulse PWM inverter. To simulate the system operations andcontrols, the hybrid

micro-grid is built in PSIMsoftware. Twenty kW PV arrays and 40 kW fuel cell are

connected to DC bus through DC/DC boost converters to simulate DC sources.

Fig. 1: Proposed hybrid DC micro-grid system.

The battery as energy storage is connected tothe DC bus through a bidirectional

DC/DC converter. Variable DCand AC loadsare connected toDC and AC buses

respectively to test the system capabilities and control during transient states when

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connecting/disconnecting loads in the system. The rated voltages for DC and ACbuses

are 400 V and 200 V rms respectively. A three-phase high pass LC filter is connected

at the output of the bidirectional PWM inverter to mitigate the high frequency ripples

generated due to the action of the PWM inverter. All the converters have the

minimum number of switches to decrease the total cost of the micro-grid.

2.2PV Array Model

The single-diode PV array is modeled by the following three equations [5].

(1)

(2)

(3)

where Ipvand V

pv

are the PV array output current and voltage, n

sis the number of cells

connectedin series, n

p

is the number of modules connectedin parallel, q is the charge

of an electron, k is Boltzmann'sconstant, A is the p-n junction ideality factor,I

ph

is the

cell photo-current, Tand T

r are the cell and reference temperatures (K), I

sat is the cell

reverse saturationcurrent,Isc is the cell short-circuit current at reference

temperatureand radiation, ki is the short circuit current temperaturecoefficient, and S

is the solar radiation inW/m

2

,I

rris thereverse saturation current at Tr, Rsand R

sh

are the

series and shunt equivalent resistances and E

g

is the band-gapenergy of the

semiconductor used in the cell.The parameters used in the PV module are listed in

Table 1 and its equivalent circuit is shown in Fig. 2-a.

Table 1 Parameters of PV model

Parameter Value Parameter Value

Referenced solar irradiance 1 000 W/m

2

Referenced cell temperature 298 K

Maximum power 20 kW Band-gap energy 1.12eV

Number of cells in parallel 29 Number of cells in series 12

Cell internal series resistance 1x10

-4

 Cell internal shunt resistance 1k

Ideality factor 1.2 Temperature coefficient 0.0702 A/K

Short circuit current 108 A Reverse saturation current 2.528x10

-6

A

Number of modules 36 Rated output voltage 200 V

2.3Fuel Cell Model

The voltage of a fuel cell Vfc

is defined as the sum of the theoretical open circuit

voltage and the different over-voltages as [6]:

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      ) exp( ) ( ln ln ln

2

229 . 1

2 2 c s c c O H fc

i n m r i i A P P

F

T R

V      

(4)

Where F is the Faraday constant (96485C), R is the universal gas constant (8.314

J/K.mol), T is the temperature in Kelvin, P

H2, P

O2

are the hydrogen, oxygen partial

pressure in bar, respectively, ic is the cell current density (A/m

2

) and A is constant, rs

is the area-specific resistance, the value of m is typically about 3x10

-5

V, and n about

8x10

-3

cm

2

/mA. Anequivalent circuit model of the fuel cell is shown in Fig. 2-b [7]

with its parameters is listed in Table 2.

D Rsh

Rs

Ipv

Iph Vpv

+

-(a)

+

-Rs

Rc

Cd

Eoc

+

-Ifc

Vfc

(b)

Fig. 2:Electric circuit models of (a) PV cell, (b) fuel cell.

2.4Battery Model

Battery model can usually be divided into experimentalmodel, electrochemical model

and equivalent electric circuit model.The equivalent circuit model is most suitable for

the dynamicsimulation.Assuming the internal resistance of the batteryconstant during

both charge and discharge cycles, the output voltage is given as [8]:

(5

)

where, Eo is battery constantvoltage (V), Q is batterycapacity (Ah),E f

is the fully

charged voltage, E

n, Q

n are the end of nominal zone voltage and capacity while E

x

and

Qx

arethe end of exponential zone voltage and capacity, Q is the capacity at any time

and i

b

is the output battery current.

Table 2 Parameters of battery model

Parameter Value Parameter Value Parameter Value Parameter Value

E

f 234V E

x 210V Qn 240Ah Qr

300Ah

Qx 60Ah E

n 200V E

o 216.5V rb 0.017

3. Hybrid DC Micro-Grid Controls

3.1 Control of PV

The PV source is connected to DC bus through a boost DC/DC converter. The PV

output power depends on the environmental conditions (solar irradiation and

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temperature). In order to generate the maximum allowable power from the PV (20

kW), its DC/DC converter is controlled using Perturb and Observation (P&O)

Maximum Power Point Tracking (MPPT) method. P&O isused most widely since it is

much simpler and needs fewermeasured variables [5]. P&O algorithm operates by

constantlymeasuring the terminal voltage and current of the PV array,then constantly

perturbing the voltage by adding a smalldisturbance, and then observing the changes

of the outputpower to determine the next control signal. If the powerincreases, the

perturbation will continue in the same directionin the following step, otherwise, the

perturbation directionwill be inversed, as shown in Fig. 3-a.

3.2 Control of FC

The control of the fuel cell converter is illustrated in Fig. 3-b. The FC and PV supply

the required powers for the DC load (Pdc), AC load (Pac) as well as the considered

power loss of the system (P

ls

). The limiter limits the maximum power of FC to 40 kW.

The required FC current is calculated by dividing its reference power by its voltageas

shown in Fig. 3-b. The reference current is used in a PI current-controlled loop to

provide the required gate signal for DC/DC boost converter.

3.3 Control of Battery

The main objective of the battery converter is tomaintain the common DC bus voltage

constant at 400V. When charging/discharging, switch S

b1/S

b2 is activatedand the

converter works as a buck/boost circuit, respectively, Fig. 3-c. The battery converter

control includes twoloopsexternal voltage control and internal current control.

3.4 Control of Inverter

The PQ control method is used to control the 3-phase PWM inverter by regulating the

d- and q-axis current components [8]. The control strategy, see Fig. 3-d, mainly

consists of two cascadedloops, namely a fast internal current loop and an

externalvoltage loop. The proposed multi-level control scheme isbased on the concept

of instantaneous power on thesynchronous-rotating dq reference frame.

4. Simulation Results and Discussions

4.1 Autonomous Mode

The hybrid DC micro-grid is simulated in autonomous mode to verify the used control

methods. The battery converter maintains the DC bus voltage at 400V. The simulation

starts with the DC load power (P

dc

) of 40kW and it descends to 30 kW at 0.5s, while

the

152

+

+

+

Pdc

Pac

Pls

Ppv

- Vfc

I

\*

fc 

¸

Ifc

PI +

-(a)

P

\*

fc

+

-V\*

dc

Vdc

PI +

-Sb1

Sb2

x

Ipv

Vref

d/dt

Ppv

+

-+dv

-dv

+

Vpv

+

-PI +

-Spv

P´>0

P´<0

(b)

(c)

Sfc

I

\*

b

Ib

PI

+

-+

-+

-V\*

dc

Vdc

PI

I

\*

d

Id

PI

+

-+

-+

Vsd

I

\*

q

PI

L

L

+

-Iq

Qr

-Vcd

Vcq

dq

abc

PLL



mabc Vc, abc



¸

Vdc/2

P

W

M

S1,2

S3,4

S5,6

(d)

Fig. 3:Control of hybrid sources (a) PV, (b) FC(c) battery and (d) invertercontrollers.

AC load power (Pac) is 20kW and steps to 40kW at 1s as shown in Fig. 4-a. The

output power of the fuel cell (P

fc

) is maintained at 40kW all time while the PV power

(P

pv

) is changing from 16-20kW according to the solar irradiation of 800-1000W/m

2

,

Fig. 4-d. Meanwhile, the battery power is changing its value and polarity, Fig. 4-b,

according to the required power for the load and for keeping the DC voltage constant.

The corresponding DC bus current (Idc

) and battery current (I

b

) are shown in Fig. 4-c.

The voltage of the DC bus (Vdc

) and the battery terminal voltage (V

b

) are shown in

Fig. 4-d. The phase voltage of the inverter (V

ai) and current (Iai

) are shown in Fig. 4-e.

The THD values of the voltage and current are much less than 5%.

4.2 Grid-Connected Mode

The DC micro-grid is simulated in the case of grid-connected mode as shown in Fig. 5.

The DC load power steps at 1s and makes another step at 1.5s. The AC load power

starts at 30kW and steps to 60kW at 0.5s, as shown in Fig. 5-a, as well as the inverter

exchange power (P

i

) from the DC bus to the AC bus. The DC sources reactions and

the grid power to supply the different loads are shown in Fig. 5-b. Until time of 0.5s,

the power direction is from the inverter to the grid, as the total DC generated power

from the FC and PV exceeds the total load. When the total load becomes 60kW

(maximum power of DC sources), the generated power from the grid is zero. When

the load power exceeds 60kW, the grid supplies the excess power.

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The corresponding DC currents of the PV, FC and DC bus are shown in Fig. 5-c. The

terminal voltages of the PV and FC are shown in Fig. 5-d. The controlled voltage of

the DC bus is shown in Fig. 5-e. It is regulated by the inverter at 400V and the shown

transient points are due to the changing of loads. The output voltage of the inverter for

phase a is shown in Fig. 5-f. The THD of the voltage is much less than the 5% due to

the presence of the well-designed LC filter.

0 0.5 1 1.5

20

40

Power, kW

(a)

0 0.5 1 1.5

-20

0

20

40

60

Power, kW

(b)

0 0.5 1 1.5

-50

0

50

100

Current, A

(c)

0 0.5 1 1.5

300

400

Voltage, V

(d)

1.44 1.452 1.464 1.476 1.488 1.5

-200

0

200

time, s

V

ai

and I

ai

(e)

P

ac

P

dc

P

fc

P

pv

P

b

V

dc

V

b

\*1.25

I

dc

I

b

V

ai

I

ai

Fig. 4: Performance of the DC micro-grid at autonomous operation.

0.5 1 1.5 2

0

20

40

60

80

Power, kW

(a)

0.5 1 1.5 2

-40

-20

0

20

40

60

Power, kW

(b)

0.5 1 1.5 2

0

100

200

Current, A

(c)

0.5 1 1.5 2

180

200

220

240

Voltage, V

(d)

0.5 1 1.5 2

380

400

420

time, s

Voltage, V

(e)

1.46 1.47 1.48 1.49 1.5

-200

0

200

time, s

Voltage, V

(f)

V

dc

P

ac

P

g

V

fc

V

pv

I

fc

I

dc

I

pv

P

dc

P

i

P

fc

P

pv

V

ai

Fig. 5: Performance of the DC micro-grid at grid-connectedoperation.

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5. Conclusions

A hybrid DC micro-grid of photovoltaic, fuel cell and energy storage battery is

analyzed and simulated under autonomous and grid-connected modes of

operations.The PV module is controlled to operate at maximum power using P&O

MPPT method. The FC provides a maximum power of 40kW using a current

controlled DC/DC boost converter. The BESS is responsible for smoothing and

regulating the DC bus voltage at 400 V during autonomous mode. The inverter is

controlled using PQ control method to provide the necessary output voltage that is

in-phase with the grid voltage with the help of a PLL circuit. The adopted control

methods show good performance of the grid at transient and steady state operations in

terms of the quality of the DC bus voltage and AC voltage.

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Life Science II

2013/03/16 Saturday 10:45-12:15 Room 603

Session Chair: Chong Kim Wong

LSBE 119

Effect of Chitosan and Modified Atmosphere Packaging on Quality Changes of

Giant Perch (Lates calcarifer) Meat during Cold Storage

Vilailak Klompong︱Thaksin University

Pidtayanan Kaewkwanpet︱Thaksin University

Supamas Chumanee︱Thaksin University

LSBE 405

Biosynthesis of value-added green material from renewable resources using a

marine Bacillus megaterium isolate KB-1

Kesaven Bhubalan︱Universiti Mal aysia Terengganu

Maizatul Nuzi Othman︱Universiti Malaysia Terengganu

Ishak Muhammad Syafiq︱Universiti Malaysia Terengganu

Mohd Effendy Abdul Wahid︱Universiti Malaysia Terengganu

Al-Ashraf Abdullah Amirul︱Universiti Sains Malaysia

LSBE 416

Characterization of allergenic compounds from Pleurotus ostreatus and

Pleurotus sajor caju

Elbatrawy Nasr Eman︱Virginia Commonwealth Univ

Ghonimy Abdouallah Eglal︱Al Azhar Uni. Cairo

Wu Fang Sheng︱Virginia Commonwealth Univ

LSBE 137

Functional Physicochemical Properties and Their Application in Food

Processing of Thai Indigenous Red Rice Varieties

Rutrada Sompong︱Thaksin University

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LSBE 322

Nutrient reduction and the marine plankton in Tolo Harbour, Hong Kong

Chong Kim Wong︱The Chinese University of Hong Kong

Alle A.Y. Lie︱The Chinese University of Hong Kong

Guangtao Zhang︱Chinese Academy of Sciences

Y. Kit Yung︱Hong Kong Environmental Protection Department

Qingchao Chen︱Chinese Academy of Sciences

LSBE 309

Methamphetamine Administration on Alterations of Sperm Quality and

Hormone receptors in Rat testis

Sutisa Nudmamud-Thanoi︱Naresuan University

Wanvipa Sueudom︱Naresuan University

Nareelak Tangsrisakda︱Naresuan University

Samur Thanoi︱Naresuan University

LSBE 300

Rubber Stand Volume Model Applications using Segmentation and Pixel-Based

Classification on Landsat TM in Selangor, Malaysia

Mohd Nazip Suratman︱Universiti Teknologi MARA

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LSBE 119

Effect of Chitosan and Modified Atmosphere Packaging on Quality

Changes of Giant Perch (Lates calcarifer) Meat during Cold Storage

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Abstract

Effect of chitosan and modified atmosphere packaging on quality changes of Giant

Perch meat during storage at 4°C for 15 days was investigated. Sample was divided

into four treatments including control, Giant Perch meat added with chitosan (5 mg /g

fish), Giant Perch meat packed by modified atmosphere (O

2 10%, CO

2 80%, N

2

10%)

and Giant Perch meat added with chitosan (5 mg /g fish) and packed by modified

atmosphere (O

2 10%, CO

2 80%, N

2

10%). As the storage time increased, moisture

loss, pH, conjugated dienes, thiobarbituric acid reactive substances (TBARS),

Trimethylamine (TMA), Total volatile bases (TVB), total plate count, psychrophiles

and Pseudomonas spp. in Giant Perch meat increased (P<0.05). The highest moisture

loss, pH, conjugated dienes, TBARS, TMA, TVB and total plate count was observed

in control (P<0.05), followed by Giant Perch meat packed by modified atmosphere,

that added with chitosan, and that added with chitosan and packed by modified

atmosphere, respectively. However, the highest psychrophiles was detected in control,

followed by Giant Perch meat added with chitosan, that packed by modified

atmosphere and that added with chitosan and packed by modified atmosphere

(P<0.05), respectively. Acceptance scores from sensory evaluation decreased (P<0.05)

as the duration of storage increased (P<0.05). However, the highest stability from

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sensory evaluation was observed in Giant Perch meat added with chitosan and packed

by modified atmosphere. Thus, natural and safe chitosan could be used together with

modified atmosphere packaging to extend the shelf life of Giant Perch meat during

cold storage.

Keyword: Chitosan, Giant Perch Meat, Modified Atmosphere Packaging

1. Objectives

To investigate the effect of chitosan and modified atmosphere packaging on quality

changes of Giant Perch meat during storage.

2. Methods

Sample was divided into four treatments including control, Giant Perch meat added

with chitosan (5 mg /g fish), Giant Perch meat packed by modified atmosphere (O

2

10%, CO

2 80%, N

2

10%) and Giant Perch meat added with chitosan (5 mg /g fish)

and packed by modified atmosphere (O

2 10%, CO

2 80%, N

2

10%) and then storage at

4°C for 15 days.

3. Results

As the storage time increased, moisture loss, pH, conjugated dienes, thiobarbituric

acid reactive substances (TBARS), Trimethylamine (TMA), Total volatile bases

(TVB), total plate count, psychrophiles and Pseudomonas spp. in Giant Perch meat

increased (P<0.05). The highest moisture loss, pH, conjugated dienes, TBARS, TMA,

TVB and total plate count was observed in control (P<0.05), followed by Giant Perch

meat packed by modified atmosphere, that added with chitosan, and that added with

chitosan and packed by modified atmosphere, respectively. However, the highest

psychrophiles was detected in control, followed by Giant Perch meat added with

chitosan, that packed by modified atmosphere and that added with chitosan and

packed by modified atmosphere (P<0.05), respectively. Acceptance scores from

sensory evaluation decreased (P<0.05) as the duration of storage increased (P<0.05).

However, the highest stability from sensory evaluation was observed in Giant Perch

meat added with chitosan and packed by modified atmosphere (Fig. 1-4).

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Figure 1 Moisture loss (a) and pH (b) of Giant Perch meat during storage at 4°C for

15 days; control ( ), modified atmosphere packaging ( ), added with

chitosan ( ) and added with chitosan and modified atmosphere packaging (

). Bars represent the standard deviation from triplicate determinations. Different

capital letters on the bars within the same treatment indicate the significant

differences (P<0.05). The different letters on the bars within the same storage time

indicate significant differences (P < 0.05).

a b

160

a b

c d

161

Figure 2 Conjugated dienes (a), Thiobarbituric acid reactive substances (TBARS) (b),

Trimethylamine (TMA) (c) and Total volatile bases (TVB) (d) of Giant Perch meat

during storage at 4°C for 15 days; control ( ), modified atmosphere packaging ( ),

added with chitosan ( ) and added with chitosan and modified atmosphere packaging

( ).Bars represent the standard deviation from triplicate determinations. Different

capital letters on the bars within the same treatment indicate the significant

differences (P<0.05). The different letters on the bars within the same storage time

indicate significant differences (P < 0.05).

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Figure 3 Total plate count (a), Psychrophilic bacteria (b) and Pseudomonas spp. (c)

of Giant Perch meat during storage at 4°C for 15 days; control ( ), modified

atmosphere packaging ( ), added with chitosan ( ) and added with chitosan and

a

c

b

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modified atmosphere packaging ( ). Bars represent the standard deviation from

triplicate determinations. Different capital letters on the bars within the same

treatment indicate the significant differences (P<0.05). The different letters on the

bars within the same storage time indicate significant differences (P < 0.05).

a b

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Figure 4 Color (a), texture (b), odor (c) and overall liking (d) from sensory evaluation

of Giant Perch meat during storage at 4°C for 15 days; control ( ), modified

atmosphere packaging ( ), added with chitosan ( ) and added with chitosan and

modified atmosphere packaging ( ). Bars represent the standard deviation from

triplicate determinations. Different capital letters on the bars within the same

treatment indicate the significant differences (P<0.05). The different letters on the

bars within the same storage time indicate significant differences (P < 0.05).

4. Conclusion

Natural and safe chitosan could be used together with modified atmosphere packaging

to extend the shelf life of Giant Perch meat during cold storage.

c d

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LSBE 405

Biosynthesis of value-added green material from renewable resources

using a marine Bacillus megaterium isolate KB-1

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Abstract

Polyhydroxyalkanoate (PHA) is a microbial derived polymer produced under

imbalanced growth conditions. It serves as an intracellular carbon and energy reserve.

PHA is considered to be a potential alternative for some petrochemical-derived

plastics because of its thermoplastic characteristics and yet it is completely

biodegradable. In this study, efforts were taken to identify PHA producing bacteria

from marine sponge samples collected from the waters surrounding Langkawi Island,

Malaysia. Marine sponges are known as ecologically diverse hotspots of unexplored

microbial communities. Here, a bacterium (KB-1) with the ability to produce PHA

was identified from tissue samples of marine sponge Callyspongia sp. The strain was

later identified to the genus Bacillus with 99% similarity to Bacillus megaterium.

Wild-type B. megaterium isolate KB-1 was found to utilize glucose as well as

glycerol, a common by-product of biodiesel production as carbon source for PHA

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accumulation. The marine isolate KB-1 is also capable of producing PHA using sea

water as growth medium and in the presence of carbon source. This eliminates the use

of conventional PHA biosynthesis medium. PHA is known for its biocompatibility

and uses in pharmaceutical and medical field. However, most types of PHA is

produced by Gram-negative bacteria and upon extraction of this biopolymer, a layer

of endotoxin is usually present. PHA produced from the Gram-positive B. megaterium

isolate KB-1 is endotoxin free, thus, eliminating additional endotoxin removal process

and suitable to be used for selected medical applications.

Keywords: polyhydroxyalkanoate, biopolymer, biodegradable, Bacillus megaterium,

glycerol

1. Introduction

PHA is a group of naturally occurring polymers synthesized by

microorganisms. It has been recognized to be thermoplastic, biodegradable,

biocompatible and possessing similar properties to synthetic petrochemical plastics [1,

2]. PHA is identified as a carbon and energy source of bacteria which is produced in

the presence of excess carbon source under conditions with limiting nutrient elements

(e.g., nitrogen, phosphorus, magnesium) [3,4]. PHA is comprised of various types of

hydroxycarboxylic acids and can be classified as homopolymers or copolymers of two

or more monomers. The monomer composition of PHA can be manipulated and

predicted by means of the carbon sources used and by changing the growth conditions.

Nevertheless, PHA synthesis mainly depends on the type of bacterial strain employed

and the substrate specificity of the PHA synthase gene (phaC) present [2]. To date

approximately 150 monomers with different structures have currently been reported

with regards to the number of carbon atoms in monomer structure [2, 4]. Among the

commonly studied PHA producing bacteria isolated from both terrestrial and marine

environment belongs to the genus Acinetobacter, Aeromonas, Burkholderia, Bacillus,

Cupravidus, Delftia, Desulfococcus, Desulfosarcina, Pseudoaltermonas,

Pseudomonas and several microalgae [5, 6, 7].

The most common type of PHA found in the natural environment is

poly(3-hydroxybutyrate) [P(3HB)] [8]. The properties of P(3HB) such as melting

temperature, flexibility, elasticity and higher elongation at breaking point was

improved by incorporating secondary monomer such as 3-hydroxyvalerate (3HV) or

4-hydroxybutyrate (4HB) [2,4]. PHA such as P(3HB) and its copolymers containing

3HV or 4HB had become attractive material in biomedical research and applications

due to its biocompatibility [1,9]. Several established PHA products such as sutures,

pins, films and screws are now being commercialised by some established companies

namely P&G (U.S.A) and Metabolix [1,4]. PHAs applications are also expanded in

wound healing management, orthopaedics and drug delivery [1,4].

The high production cost of PHA is the major setback for commercialization

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[9]. The high cost includes set-up of fermentation systems, carbon feed stocks and

downstream processes which requires the usage of various chemicals and enzymes

[9,10]. Research is now geared towards minimizing the production costs of PHA by

isolating suitable PHA producers capable of generating high yields of PHA, screening

for strains capable of utilizing cheaper and renewable carbon sources as well as

growing in simple growth medium, and genetically engineering strains to improve its

PHA producing ability [4,9,10]. Here we report the efforts taken to identify PHA

producing bacteria from marine sponge samples collected from the waters

surrounding Langkawi Island, Malaysia. Marine sponges are known as ecologically

diverse hotspots of unexplored microbial communities. The high level of biological

activity in the sponges is believed to reveal PHA producing bacteria with varying

potentials.

2. Results and Discussion

A bacterium (KB-1) with the ability to produce PHA was identified from

tissue samples of marine sponge Callyspongia sp. The strain was later identified to the

genus Bacillus with 99% similarity to B. megaterium. B. megaterium isolate KB-1

was able to use glucose and glycerol as carbon source for the production of P(3HB).

From previous studies, Bacillus is known to produce P(3HB) from carbon sources

such as glucose, fructose, 1,4-butanediol and plant oils [9,11]. PHA accumulation in

bacterial cells can be controlled by varying the ratio of carbon to nitrogen (C/N). The

C/N ratios of 20 – 50 are widely used for PHA biosynthesis [12]. The production of

P(3HB) by B. megaterium isolate KB-1 was investigated by varying the ratio of (C/N).

glucose was used (Table 1a). The P(3HB) was found to decrease at C/N ratio above

35. On the other hand, when glycerol was supplemented as the carbon source, highest

P(3HB) content was detected with C/N ratio of 45 and it decreased with C/N ratio

above 50 (Table 1b). The results show that this strain has different preference of C/N

ratio based on the type of carbon source used.

Table 1a: Production of P(3HB) using glucose at different C/N ratio

a

.

Carbon source C/N P(3HB) content (wt%)

b

Glucose 15 16 ± 3

20 24 ± 3

25 30 ± 3

Table 1b: Production of P(3HB) using glycerol at different C/N ratio

a

.

Carbon source C/N P(3HB) content (wt%)

b

Glucose 35 12 ± 1

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40 14 ± 1

45 20 ± 1

a.

The cells were harvested after 72 hours cultivation at 200 rpm at RT.

NH4

Cl was used as the nitrogen source. Data shown are means of

triplicates.

b.

The P(3HB) content was determined via GC analysis.

B. megaterium isolate KB-1 was grown is sea water as the growth medium and

supplemented with glucose as carbon source. The findings show the possibility of this

strain to accumulate P(3HB) in its natural environment in the presence of excess

carbon source. B. megaterium isolate KB-1 was able to produce 15 ± 1 wt % of

P(3HB) in sea water using glucose as the carbon source and up to 21 ± 3 wt% when

sea water was added with mineral salts used to prepare the common PHA biosynthesis

medium (Na2HPO4, KH

2PO4 and NH

4

Cl) [Table 2]. In a previous study, marine Vibrio

spp. cultured in sea water as the PHA production media showed similar results of

P(3HB) content and cell biomass [13]. The ability These results of P(3HB) production

and cell growth was suggested to be improved by optimizing the salinity of the culture

media at the optimal range in order to reduce high osmotic stress and its effect on

P(3HB) production [13]. Such attempts could be made in the future with isolate KB-1

in order to improve its PHA producing ability.

Table 2: Production of P(3HB) by B. megaterium isolate KB-1 using sea water

a

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Production media P(3HB) content (wt %)

b

Sea water 15 ± 1

Sea water and mineral salts 21 ± 3

a.

The cells were harvested after 72 hours cultivation at 200 rpm at RT.

NH4Cl was used as the nitrogen source. Data shown are means of

triplicates.

b.

The P(3HB) content was determined via GC analysis.

3. Conclusion

B. megaterium isolate KB-1 was able to grow and produce P(3HB) using

simple sugar such as glucose and glycerol, a common by-product of biodiesel

production. It was interesting to note that this strain could produce P(3HB) without

any growth limitation in sea water. Most strains require limitation of certain essential

nutrients such as nitrogen or phosphorus. The P(3HB) content was in the range of

17–21 wt%. The ability to use sea water as the culture medium and glycerol as carbon

source might help to reduce the overall P(3HB) production cost. In future, a

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transformant B. megaterium isolate KB-1 will be constructed to further analyze its

ability to synthesize different PHA monomer using various renewable carbon sources.

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LSBE 416

Characterization of allergenic compounds from Pleurotusostreatus

and Pleurotussajorcaju

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Abstract

Our study aims to isolate and purify allergenic compounds from two investigated

mushroom strains, Pleurotusostreatus and Pleurotussajorcaju. Furthermore, the

purified allergens were subjected to biochemical investigations in an attempt to

determine its nature and characterization. Crude extracts of P. ostreatus and P.

sajorcaju (spores, mycelia, broth, fresh and cooked fruit bodies) were tested by skin

prick test onto three groups; A, B and C (patients suffered from allergy, mushroom

workers and normal cases respectively). Positive response toward the extracts was

detected in numbers of patients and mushroom workers, while negative response was

detected for the normal cases and the extract of cooked mushrooms for all cases. The

crude extracts were fractionated; all fractions were subjected to antigen-antibody

reaction using ELISA. The effective allergens appeared in fraction no. 6 in spores and

broth extracts of the investigated strain, while appeared in fraction no. 8 in the case of

mycelia and fruit bodies extracts. Characterization of the active fractions was

performed using spectrophotometer, capillary electrophoresis, and amino acid

analysis, as well as mass, IR and NMR spectroscopy. Our results indicate that this

strain possessed four different allergens which were proteinic in nature. Keywords:

Pleurotusostreatus, Pleurotussajorcaju allergy, ELISA, protein.

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Keyword:Pleurotusostreatus, Pleurotussajorcaju, allergy, ELISA, protein.

1. Introduction

Human health represents a real and hard challenge, the protecting of human health is

an integral part of our life. Allergens are widely found in several food and feed, and

also widely distributed in the air where unavoidable contaminants are present. There

is a positive Relationship between concentration of Immunoglobulin E (IgE)

antibodies and the concentration of allergenic compounds where IgE produced due to

stimulation of the immune system by antigen (allergens) resulted in production of IgE

mediated reaction[1]. The immediate positive skin test reactions in the prick-to-prick

tests, and the demonstration of a significant amount of IgE to shiitake and oyster

extracts supported the allergic, IgE-dependent pathogenesis of this occupational

asthma [2]. Horner [3] reported that more than 80 genera of fungi have been

associated with symptoms of respiratory tract allergy. The famous five genera

producing allergens (belonging to basidiomycetes) are Calvatia spp., Coprinus spp.,

Ganoderma spp., Psilocybecubensis and Pleurotus spp. Oyster mushrooms

(Pleurotusostreatus) are cultivated for human consumption in various subspecies.

Their spores are highly potent allergens which can cause exogenous allergic alveolitis,

hypersensitivity pneumonitis (HP) and occupational asthma by mushroom spore

proteins [2]. About 30-40% of mushroom worker infected by respiratory allergic

reaction due to inhalation of oyster mushroom spore which released vigorously into

the atmosphere of growing rooms [4]. Spores allergy is one of the most important

limiting factors for the large scale cultivation of Pleurotussajorcaju. Different

approaches are being adopted for the production of commercial sporeless/low-sporing

strains of Pleurotus through ultraviolet (UV) mutation to alleviate the spores allergy

problem [6, 5].

2. MATERIALS AND METHODS

Fungal strain, Spores print, and Preparation of crude extracts

Pleurotus sp. was used in the present study obtained from the Fujian Edible

Mushroom Association, Fuzhon, China and Fujian Jun-Cao Develop Project

Association, China (P. ostreatus NO. 239 and P. sajorcaju NO. 292).Ou r

invistegated mushrooms were inoculated and cultivated according to [7, 8, 9, 10].

Spores print was determined according to Thomas [11]. All spores collection

processes yielded >95 % of pure spores as determined by Image analysis system

(system soft imaging system GmbH software (analysis pro ver.3.0). Crude extracts

were extracted from spores according to Horner [7].

Population study, clinical profile, blood investigation of (the patients, mushroom

workers and normal cases) and skin prick test

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The five crude extracts from spores, mycelia, broth, fruit bodies and cooked fruit

bodies were injected into three groups of 37 volunteers, 17 of them (group A) with

personal history of respiratory allergy attending the charity hospital of Tanta allergy

clinics at university of Tanta, Cairo. The second group (group B) consisted of 15

persons worked in the field of mushrooms cultivation. Group (c) 5 normal adult cases.

Blood investigation of volunteers, 10 ml of venous blood was withdrawn from each

patient to perform complete blood picture (CBC) and Immunoglobulin E (IgE).Only

one case of each group (which has the highest concentration of IgE) was selected for

performance of antigen-antibody reaction between all fractions and the sera of

selected cases, to determine the active fractions. The absorbance was measured at 450

nm using ELISA Reader (Sunrise TecanAustria 5082 Ref. F039300; Incubator

Awareness Technology Inc. model stat fox-2200 Washer Tecan M8/2R Colunmbus

plus A-5082 Austria F109201) [12]. Skin prick test was performed by 5 mg of

lyophilized crude extracts were dissolved in 1 ml glycerol (50%) by phosphate buffer

pH 7.2 (v/v) [7].

Purification of antigenic proteins and Biochemical analyses:

The Pharmacia column (40×2 cm) was packed by sephadex G l00 after its soaking

with phosphate buffer (pH 7.2) overnight and the samples were mixed with blue

dextran and bromophenol blue dyes, and loaded on the top of the column and

fractionated using LPLC system (pumb model MINI Puls3, detector UV∕VIS-151 FC

203B, Gilson). The total protein of the active fractions was determined by Lowry

method [13] and as modified by Waterborg and Mathews [14]. Followed by

determination of total soluble carbohydrates of the active fractions were determined

by the anthrone reagent method as described by Umbriet [15]. The active fractions of

the investigated strain were applied to capillary electrophoresis (Biofocus 3000,

Bio-RAD, USA), using SDS-protein Kit for the determination of the molecular

weights [16]. Proteinic amino acid profile of the active fractions was determined

using amino acid analyzer system (Model eppendorf, Biotronik, LC 3000, the

hydrolysis cation-exchange column was used and the resin particle size was 4 µm and

the column size was 125×4mm) [17]. The active fractions were subjected to Mass

spectroscopy using DI- 50 unit of Shimadzu GCMS-QP5050A [18]. The infrared

absorption spectrum of the purified active fractions was estimated using BRUKER,

Vector 22, Germany [19]. The active fractions were subjected to the proton (1H)

NMR spectra and were recorded in deutrated dimethyl sulphoxide (DMSO-d6) on a

Varian a Mercury-VX-300 NMR spectrometer [20].

3. RESULTS and Discussion

Clinical profile and blood investigation of the investigated cases

Crude extracts of spores, mycelia, fruit bodies and fungal broth of the investigated

mushrooms P. ostreatus and P. sajorcaju were applied onto 37 volunteers who

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divided into two groups.The first group (group A) consisted of 17 patients who

suffered from allergy ranged from 3 cases suffered from asthma (17.6 %), 2 cases

suffered from rhinitis (11.76 %) and 12 cases suffered from asthma and rhinitis (70.5

%). The second group (group B) consisted of 15 mushroom workers, eight of them

suffered from asthma and rhinitis(53.4 %) during working in green house, (46.6%)

were suffering from rashes during their work in green house. The values of total

immunoglobulin E of group A were higher than of group B.IgE ranged from 18 to 965

IU/ml, meaning that not all of the investigated cases have a high level of IgE and this

result agreed with Allansmith [21] who reported that there is a positive relationship

between both the scope and the number of different allergens and the concentration of

IgE. Eosinophils count of volunteers possessed a high reading especially in the cases

of high reading in IgE count and these results are consistent with Butterfield [22] who

reported that when IgE reach and reacted with mast cells and basophils cells promote

the production of inflammatory mediators.

Toxicity test.

No toxic effect was observed on female Swiss Webster mice that were injected by

spores, mycelia, fruit bodies(fresh and cooked) extracts of P. ostreatus and P.

sajurcajuand fungal filtrate at all investigated time intervals and after 72 hours.

Skin prick test of group A and B toward the investigated mushroom extracts:

Spores extract of each strain showed the highest allergenic effect toward all cases.

Mean wheel and flare diameters stimulated by spores extracts were higher than that

exerted by mycelial, broth and fruit bodies extracts. While, cooked fruit bodies of

both organism reveal negative result. the mean wheel and flare diameters of P.

ostreatus spores, mycelia, broth and fruit bodies extracts were slightly increased than

that stimulated by P. sajorcaju extracts in most cases. Also, the highest mean wheel

and flare diameters were observed with spores extract of both P. ostreatus and P.

sajorcaju, while the lowest mean wheel and flare diameters were produced by fruit

bodies extract. These results may be attributed to the age of cases, duration of illness,

type of antigen and also due to the differences of immune system expression. Brian

[23] stated that prevalence of basidiospores specific positive skin prick test for each

spores extract varied from a low of 28.6 for Pisolithustinctorius to a high of 55.6% for

Geastrumsaccatum, 54.8 % for Coprinusquadrifadus and 42.9% for

Pleurotusostreatus. Concerning the allergenic potency of fungal crude extracts, the

foregoing results show slight increase in the potency of spores, mycelia, broth and

fruit bodies of Pleurotusostreatus respectively. Similar findings were observed by

Samuel [8]. Spore extract of Cladosporiumcladosporides is more potent than the

mycelial extract of the same organism. Additionally it was clear that both mycelium

and spore extract have totally different allergenic compound however, in certain cases

mycelial extract of Alternariaalternatahave greater potency than of spores due

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probably to higher concentration of the allergens [24]. The mean wheel diameter of

skin prick test of crude extracted of the investigated mushroom varied from 4-7.9 mm,

with the greatest reaction value observed with spores followed by mycelia, broth and

fruit bodies extracts these results agreed with that reported by [8,24].

Determination of antigen-antibody (Ag-Ab) reaction of crude extracts of P.

ostreatus and their fractions with serum of selected patient, mushroom worker

and normal case using ELISA.

purified fractions of P. ostreatus spores, mycelia, broth and fruit bodies contained

high antigenic concentrations compared to the values of respective forms of crude

extracts appeared in fractions no 6,8,6 and 8 respectively with values of 163, 76, 70

and 64 IU ∕ ml in case of patient serum.While in case of mushroom cultivator serum

appeared to be (150, 72, 66, and 60 IU ∕ ml) lower than that of patient one. While, the

highest concentration of purified antigen of P.sajorcaju compared to that of crude

extract without purification (72, 65 ,62, 61 IU ∕ ml) while the antigen concentration of

crude extracts of spores, mycelia, broth and fruit bodies were 151, 72, 70 and 63 IU

∕ ml respectively with mushroom serum. In conclusion our results revealed that, P.

ostreatusextracts are rich in allergenic compounds more than P. sajorcaju. And spore

of each strain possesses higher allergenic activity than mycelium extract followed by

broth extract. However the lowest activity were viewed with fruit bodies extracts in

both of them. But, antigen antibody reaction with selected mushroom cultivator case

was lower than that observed in patient case. Our results agree with that demonstrated

by Asturias [27] who reported that nowadays diagnosis of allergic disease and therapy

based on the crude allergen extracts, and we have to consider that the composition and

potency of allergenic compounds may differ from extract to extract according to

nutrition, atmosphere and different measurements. Gel filtration enhanced the

radioallergosorbent test (RAST) activity of the active pool relative to crude extract [7].

This result attributed to a greater concentration of allergen(s) in the sephadex G 75

fraction, by removal of inert material or the removal of substances inhibitory to the

coupling reaction between allergens and antibodies.

Characterization of the purified allergens.

Protein concentrations of the antigenic fraction P. ostreatus spores, broth, mycelia and

fruit bodies were 0.031, 0.021, 0.024, and 0.020 mg/ 100 ml respectively. While, it

was 0.030, 0.027, 0.019 and 0.21 in case of P. sajorcaju respectively. However, the

results revealed that, active fractions were free from soluble carbohydrates. There are

three different molecular weights ranged from 31 KDa to 90 KDa were determined

using capillary electrophoresis. Our result disagree with Horner[10] who reported that,

allergen extract of P.ostratus spore are low molecular weight less than 10 KD.

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Amino acid composition of the antigenic fractions (P. ostreatus and P. sajorcaju)

Histidine was detected only in the fruit bodies. Regarding to amino acid contents of P.

sajorcaju, proline was detected only in mycelia and broth. While, methionine, phenyl

alanine and lysine were found in mycelia, broth and fruit bodies. The characteristic

amino acids composition of spores, mycelia and broth allergens of P. ostreatus and P.

sajorcajurevealed the presence of arginine in high concentration, Nevertheless,

allergens recorded relatively moderate to high quantities of amino acids as aspartic

acid in broth and fruit bodies, glycine in mycelia, broth and fruit bodies allergens,

alanine in mycelia and broth, leucine and tyrosine in fruit bodies allergen, proline in

mycelia and broth allergen, and lysine in broth allergen. Allergens from mycelia and

broth possessed the same amino acids but different in concentrations. Obviously,

these allergens were rich mainly in aspartic acid, glycine, arginine, and proline, also

contain moderate concentration of glutamic acid. These results are somewhat similar

to that reported by Heimo and Christof [28] who found that the Berthoolletia excels

contains allergenic protein known as 2S albumins this protein is rich in arginine,

glutamine, asparagine, and often cysteine.

Identification of pure antigen compounds.

The mass spectrum of active fractions P. sajorcaju spores, mycelium, broth and fruit

bodies reveals that the fraction was pure and the molecular ion peak (M+) was

256,165,273and 319 respectively. Regarding P.ostreatus active fractions it was

407,303,275 and 279 respectively. The IR spectrum of the pure fractions shared

absorption bands ranged from 3315-3494 cm-1 due to the presence of –NH2 group,

shared absorption bands ranged rom1080-1310 cm-1 for –C– N group (amine),

For –C=C– alkene group (1599-1652).While amide group represented only in active

fractions of P.ostreatus spore and mycelium of P. sajorcaju. And 1403-1451 cm-1

for –C=C– group (alkene) only in case of mycelium and fruit bodies of P. ostreatus.

The results of Nuclear Magnetic Resonance spectroscopy reveals different signals as

follows 3.617 δ for –C– N group (amine), 2.495 and 2.231δ for CH2 group (alkane),

1.885 δ for C–CH3 and 0.861δ for R–CH3. And explain the presence of aromatic

group in active allergenic compounds of spores and broth of P.sajorcaju also, active

fraction of P.ostreatus. Allergens extracted from P. ostreatus were proteinic in nature,

possessing special features that influence allergenicity potentiality. The size,

physicochemical properties of the protein and the way in which the protein is

processed and presented to the immune system affected the potential allergenicity.

Also, specific amino acids might play a role in allergenic potency and determine its

activity.

4. Conclusion

Antigens were detected in patients and mushroom workers and this might be due to its

presence in high concentrations in air. Allergens extracted were proteinic in

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nature,possessing special features that influence allergenicitypotentialitywhich may

disappear by heating. The size, physicochemical properties of the protein and the way

in which the protein is processed and presented to the immune system affected the

potential allergenicity. Also, specific amino acid might play a role in allergenic

potency and determine its activity.

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LSBE 137

Functional Physicochemical Properties and Their Application in

Food Processing of Thai Indigenous Red Rice Varieties

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Abstract

Red rice is pigmented rice, which has good nutritive properties, high content

of polyphenolic compounds and high antioxidative capacities. Thus, it offers a high

potential for production of functional food. The aims of this study were to

characterise the chemical functional and physical properties of various indigenous

red rice varieties and to investigate the influence of food processing (drum drying,

heat moisture treatment, yellow alkaline noodles production and rice beverages

production) on their properties. Six red rice varieties from Thailand were determined

for proximate composition, total phenolic content (TPC) and their antioxidant

activities. The proximate composition (g/100g) of all red rice tested was 9.28 - 13.12

moisture, 2.37 - 3.19 fat, 7.16 - 10.36 protein, 1.26 - 1.50 ash, 3.17 - 4.51 total

dietary fibre and 73.73 – 77.53 total carbohydrate. Highest antioxidant activity and

TPC was found in Bahng Gawk varieties. Varieties with the highest amylose showed

the highest peak viscosity and final viscosity (p<0.05) while contrast resulted with

low amylose rice varieties. All applied food processes affected the functional and

physicochemical properties of the final products. However, all products had

remaining levels of functional properties which still allows to recommend their use

for functional food production.

Keywords: Red rice; Drum drying; Heat moisture treatment; Yellow alkaline

noodles; Rice beverages

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LSBE 322

Nutrient reduction and the marine plankton in ToloHarbour, Hong

Kong

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Abstract

ToloHarbour is a semi-enclosed bay in the northeastern corner of Hong Kong. During

the 1980s, excessive nutrient loading led to a dramatic increase in nutrient

concentrations, which in turn caused noticeable increases in algal biomass and algal

bloom occurrences. An action plan to reduce nutrient loading was launched in 1987

and became fully operational in 1998. Comparison between data collected before

(1986–1997) and after (1998–2008) the full implementation of the nutrient reduction

measures revealed significant decreases in the concentrations of total nitrogen, total

phosphorus and silica. Decrease in nutrient levels was accompanied by significant

decreases in chlorophyll-a biomass and the number of algal blooms.The density of

dinoflagellates did not change significantly, but increases in the densities of diatoms

andsmall flagellates led to a significant increase in the abundance of total

phytoplankton. The zooplankton in ToloHarbour was dominated by copepods, and a

comparison of the copepod communities in 19871991 and 20032004 revealed that

copepod densities were much lower in 20032004(4,810 ind.m

-3

)compared to

19871991 (6,392 ind.m

-3

). Increase in the abundance of diatoms and small

flagellates suggests that the observed decrease in copepod densities was not caused by

food limitation. Small copepods, notably species of Paracalanusand Oithona,

dominated the copepod communities both before and after nutrient reduction, but an

increase in species evenness, caused mainly by an increase in the number of

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speciesfrom 48 in 19871991 to 52 in 20032004, was recorded after nutrient

reduction. Nutrient reduction had therefore led to considerable changes in the

plankton community and the dynamics of the planktonic food web in ToloHarbour.

Keywords: nutrient, phytoplankton, zooplankton, ecology

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LSBE 309

Methamphetamine Administration on Alterations of Sperm Quality

and Hormone receptors in Rat testis

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Abstract

Methamphetamine (METH) is a psychostimulantwhich can degenerate neurons and

induce psychosis. METH can cause apoptosis in seminiferous tubule and changes of

plasma testosterone concentration. Therefore, the present study was carried out to

investigate the effect of METH dependence on rat sperm quality and expressions of

progesterone receptor (PR) and estrogen receptors (ER) in seminiferous tubules of rat

testis. Sperm quality parameters including sperm motility, sperm morphology and

sperm concentration were examined. Immunohistochemistry was used to

demonstrate PR andERβ expressed cells. The percentages of normal sperm motility

and normal sperm morphology were significantly decreased in animals treated with

METH when compared with controls, especially in escalating dose (ED METH) and

escalating dose-binge (ED-binge METH) groups. In addition, sperm concentrations

in ED METH and ED-binge METH groups were numerically decreased when

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compared with the control group but it just failed to reach significant. Furthermore,

the expressions of PR andERβ were significantly decreased in spermatogenic cells

and sertoli cells per total cells in each cell type in all METH treated animals.These

results indicate that METH can induce abnormal sperm quality. These changes of

sperm quality may relate to fertilizing abilities of sperm.A decrease of PR and ERβ

expressionsin spermatogenicand sertolicells may lead to impairments of

spermatogenesis and fertilizing ability of sperm.

Keywords: rat testis, methamphetamine, sperm quality, estrogen receptor,

progesterone receptor

1. Introduction

Methamphetamine (METH) is an illicit drug which has a primary action in the brain.

METH has been reported as a neurotoxicant (1) which can induce euphoria, alertness,

anxiety, hallucination and psychosis (2,3).METH also has effects in reproductive

system. It can induce apoptosis in seminiferous tubules and changesof serum

testosterone concentration in male mice (4,5,6). Recently, METH has been reported to

decrease normal sperm morphology and sperm count and increase apoptotic cells in

seminiferous tubule (6). Moreover, METH can decrease proliferation of

spermatogonia and the ratio of proliferation/apoptosis in seminiferous tubule of rat

testis (7). Progesterone and estrogen are hormones that play a role in spermatogenesis

(8). The functions of progesterone are associated with sertoli cell function,

spermiogenesis, sperm capacitation, and synthesis of testosterone as well as induction

of hyperactive sperm motility and acrosome reaction of mammalian spermatozoa

(9,10). Estrogen is an important hormonefor proliferation and differentiation of germ

cells during development and inhibiting apoptosis in testis (11).

However, study of METH addiction with doses that imitate METH addiction in

human has not been reported its effects in reproductive system. Therefore, the

objective of this study was to investigate the effect of METH addiction that imitates

METH addiction in human on the alterations of sperm quality andexpressions of ER

and PR in seminiferous tubule of male rat

2. Main Body

2.1 Materials and Methods

Animals and drug administration

D-methamphetamine hydrochloride (Lipomed AG, Arlesheim, Switzerland) with the

consent from the Ministry of Public health was used in this experiment.24 male

Sprague-dawley rats (National Animal Center, Salaya, NakornPathom). The protocol

for this study was approved by the Animal Research Committee of Naresuan

University, Thailand. Animals were divided into 4 groups with 6 animals each. In

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control group, rats were treated with 0.9% saline 3 times per day for 14 days and 4

times at 2 hours intervals on day 15. In acute binge (AB METH) group, rats were

treated with 0.9% saline 3 times per day for 14 days and treated with 6mg/kg METH

4 times at 2 hours intervals on day 15. In escalating dose (ED METH) group, rats

were gradually increase treated with METH3 times per day for 13 days and treated

with 4.0 mg/kg METH 3 times on day 14 and treated with 0.9% saline 4 times at 2

hours intervals on day 15. In escalating dose-binge (ED-binge METH) group, rats

were gradually increase treated with METH3 times per day for 13 days and treated

with 4.0 mg/kg METH 3 times on day 14 and treated with 6 mg/kg METH 4 times at

2 hours intervals on day 15. After treatments, rats were sacrificed by cervical

dislocation and cauda epididymis was removed to release spermatozoa in phosphate

buffer saline.

Sperm quality

Sperm motility was immediately evaluated after release from cauda epididymis.

Motile and non-motile sperm were counted and expressed in percentage of normal

sperm motility . After that, semen samples were fixed and stained with eosin solution

to evaluate sperm morphology. 200 spermatozoa per animal were evaluated and

sperm morphology was expressed in percentage of normal sperm morphology. To

evaluate sperm concentration, spermatozoa were counted and expressed in millions

per milliliter (10

6

/ml).

Immunohistochemistry

Testicular tissues were fixed and histologically performed by auto-tissue processor.

Testicular sections were processed for antigen retrieval and incubated with 5% normal

goat serum. Testicular sections were then incubated with primary antibody comprised

of progesterone receptor (PR) (Santa Cruz, Biotechnology, Santa Cruz, California),

estrogen receptor beta )ERβ) (Santa Cruz, Biotechnology, Santa Cruz, California(.

Testicular sections were incubated with biotinylated secondary antibody,

avidinbiotinylated horseradish peroxidase complexes )ABC kit) (Vector Laboratories,

Burlingame, California(, respectively. The specific proteins were visualized by

chromogen 3, 3-diaminobenzidine )DAB(substrate)Vector Laboratories, Burlingame,

California). The immunoreactive cells were quantified with Image J Program (Version

1.45).

Statistical analysis

One way ANOVA following by post hoc Dunnett test were used for statistical

analysis.

2.2Results

The percentages of normal sperm motility and normal sperm morphology were

significantly decreased in all groups of METH treated animals. However, the sperm

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concentrationswere not reached significance when compared with control.Percentage

of normal sperm motility was significantly decreased in AB METH group

(32.79±5.35%), in ED METH group (45.50±2.83%), and in ED-binge METH group

(42.66±4.71%) when compared with control group (66.50±2.79%) (Figure 1).

Percentage of normal sperm morphology was significantly decreased in ED METH

group (49.20±1.39%), and in ED-binge METH group (44.08±4.53%) when compared

with control group. (68.33±7.41%) (Figure 2). The sperm concentrations were

numerically decreased in ED METH group and ED-binge METH group when

compared with control group, but it just failed to reach significant (Figure 3).

The immunohistochemistry demonstrated that PR and ERβ were expressed in all

types of spermatogenic cells as well as sertoli cells in seminiferous tubule.

Quantitative results demonstrated that the percentage of PR expression was

significantly decreased in all METH treated animals in every cell types especially

sertoli cells when compared with the control (Figure4). Similarly, ERβ expressions

were significantly decreased in all METH treated groups (Figure 5).

Figure 1. Percentage of normal sperm motility of male rats after treated with METH

compared with control group. Data are presented as mean±SEM, n = 6, \*\* P<0.01 vs

control group and \*\*\* P<0.001 vs control group.

Figure 2. Percentage of normal sperm morphology of malerats after treated with

METH compared with control group. Data are presented as mean±SEM, n = 6, \*

P<0.05 vs control group and\*\* P<0.01 vs control group.

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Figure 3. Sperm number of cauda epididymis (x10

6

/ml) of male rats after treated with

METH compared with control group. Data are presented as mean±SEM, n = 6

Figure4. The percentage of PR expression in each all type cells/total cells in

seminiferous tubulesof control (brown), ED-binge METH (red), ED METH

(green)andAB (violet)

a

p<0.05,

b

p<0.01 and

c

p<0.001 one-way analysis (ANOVA

post – hoc Dunnett test).

Figure5. The percentage of ERβ expression in each all type cells/total cells in

seminiferous tubulesof control (brown), ED-binge METH (red), ED METH

(green)andAB (violet)

b

p<0.01 and

c

p<0.001 one-way analysis (ANOVA post –

hocDunnett test).

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3. Discussions

The results demonstrated that animals treated with METH that imitates human

addiction show abnormal parameters of sperm quality, especially sperm motility and

sperm morphology. These results are in agreement with a previous study which

reported a decrease of normal sperm morphology in seminiferous tubulesafter chronic

exposure of METH (6). A reduction of sperm motility of male mice has also been

reported in animals treated with 15 mg/kg METH at 24 and 48 hours after

administration (12). However, 15 mg/kg METH used in that study seemed to be

higher than daily consumption of METH dependence.

The present study also demonstrated the effects of METH on the alteration of PR,

ERβ and ERα expressions in spermatogonic cells and sertoli cells in seminiferous

tubule of rat testis. The deceases of PR and ERβexpressions in spermatogonic cells

and sertoli cells, in particular, may affect the process of sperm production as

progesterone and estrogen have been reported to be essential hormones for

spermatogenesis (8).

In conclusion, METH administration that imitates human addiction can induce

abnormalities in sperm quality. Decreases of sperm motility and sperm morphology

caused by METH may be involved their fertilizing abilities of sperm leading to

reproductive problems in males.A decrease of PR and ERβ expressionsin

spermatogenicand sertolicells may lead to impairments of spermatogenesis and

fertilizing ability of sperm.This present study, therefore, can reflect toxicity of

methamphetamine in male reproduction.

4. Acknowledgements

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LSBE 300

Rubber Stand Predictive Model Applications using Pixel-Based

Classification and Image Segmentation on Landsat TM in Selangor,

Malaysia

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Abstract

Rubber tree (Hevea brasiliensis) plantations in Malaysia are important sources of

natural rubber and wood products. Effective management and appropriate policy for

these resources require reliable information on resource dynamics and forecasts of

resource availability. The need for inventories and monitoring systems prompted this

research into utilising ground information and satellite imagery for developing

methods for plantation inventory. The objectives of this study are to demonstrate the

application of volume estimation procedure, based on prediction models developed by

Suratman et al. (2004), across an extended sample of rubber plantations south of

Kuala Lumpur, Malaysia and to perform image segmentation and pixel-based

techniques for application of rubber stand predictive models on Landat TM imagery.

For image segmentation, the mean of spectral radiance of rubber stands were

extracted by segments, and then the equation was applied to each segment. The image

segmentation technique resulted in 812 rubber segments, with segment areas ranging

from 1.5  14 ha. The mean area of the segments was 3.3 ha, and the estimated mean

of rubber volume derived from the model was 237 m

3

/ha. For pixel-based

classification, a reasonable signature separation between the five rubber volume

classes and the four land use/cover types (i.e., water bodies, forests, cleared areas, and

urban) was achieved. In conclusion, both techniques can be a useful tool for

estimating average volume within localised areas. In the context of rubber plantation

management and planning, segmentation technique is preferred as it partitions rubber

pixels into spatial units that could be referred to as rubber estates or rubber small

landholding units.

1. Introduction

The total natural forest area in Malaysia is 18.9 million ha, or 57.5% of the total land

base. Of this total, 14.3 million ha has been set aside for a permanent forest reserve to

be managed sustainably. From this area, about 10.9 million ha are production forests

and 3.4 million ha are protection forests [1]. An additional 2.4 million ha of forest

area is known as conversion forest, which in due time, will be converted to other uses

to meet the needs of population growth and balanced economic development. In

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addition to natural forests, the country has established about 0.19 million ha of forest

plantations consisting of fast growing tree species such as acacia (Acacia mangium

Willd.), batai (Albizia falcataria (L.) Fosb.), and yamane (Gmelina arborea Roxb.).

Additionally, Malaysia has approximately 4.82 million ha of agricultural tree crops

which are mainly rubber, oil palm, coconut, and cocoa [2].

Rubber tree crops play pivotal roles in providing natural rubber, sources of wood

products, and other benefits that support basic human needs and economic

development [1][3]. Despite their importance, little attention has been given to

inventory, mapping, and monitoring the crops. This could be because government

agencies are often under-funded, thus data on tree crop resource monitoring tend to be

sporadic. In spite of the country’s awareness of the socio-economic roles of rubber

plantations, a decline in the total area of rubber plantations in Malaysia occurred

throughout the 1990s. In 2000, Malaysia had about 1.43 million ha of rubber

plantations compared to 1.02 million ha in 2011, representing about a 29% reduction

[4]. The objectives of this study are to demonstrate the application of the rubber area

and stand volume prediction models developed by Suratman et al., [5] across an

extended sample of rubber plantations south of Kuala Lumpur, Malaysia and to

compare pixel-based and segmentation techniques for the application of rubber stand

predictive models on Landat TM imagery.

2. Materials and Methods

2.1 Study Area

The area chosen was located about 20 km south of Kuala Lumpur, in the State of

Selangor, Malaysia, between 101

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25’and 101

o

45’ E latitudes and 2

o

50’ and 3

o

05’ N

longitudes, covering about 250 km

2

. The region has a tropical climate characterised

by a dry season (March to May) and a wet season (November to January), with a

mean annual precipitation of 2,178 mm. Daytime mean temperature ranges from

22.9

o

C to 27.7

o

C (Meteorological Service 2002). The selected area consists of three

districts namely Petaling, Sepang, and Kuala Langat. The topography in the area is

predominantly flat, with altitudes ranging from 5 – 80 m above sea level. The forest

type is Lowland Dipterocarp Forests, which contains a high percentage of commercial

tropical hardwood species. Crop types are primarily rubber and oil palm plantations,

as well as varying sizes of mixed crops. The mixed crops are characterised by diverse

intercropping of traditional homegarden systems, with a mixture of coffee, cocoa,

coconut, banana, shrubs, and herbaceous plants [6].

2.2 Satellite Image Acquisition

The remote sensing data consisted of a full scene image of the State of Selangor (path

127/row 58), Malaysia from the TM sensor on Landsat-5. Available reference data to

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support this work consisted of a 1999 State of Selangor map at a scale of 1:125,000

(series 9101), and 1990 topographic maps at a scale of 1:50,000 (sheet numbers 3756

and 3757), both produced by the Department of Survey and Mapping, Malaysia. The

land use and land cover and soil maps were obtained from the Department of

Agriculture, Malaysia.

2.3 Image Pre-Processing

A PCI Geomatica (Version 7.0) software was used to perform all image -processing

functions required to complete the land use/cover classification and change analyses

[7]. ArcView GIS (Version 3.2) was used to carry out data management and a spatial

analysis [8]. Geometric correction was performed for producing spatially corrected

maps of land use/cover.

2.4 Application of the Rubber Area Model

The rubber area model based on logistic regression developed by Suratman et al. [5]

was applied to the 1999 Landsat TM imagery using the MODEL command in ‘Xpace’

utilities of PCI Geomatics software [7]. Output bitmaps of predicted rubber pixels

were produced where the probability of rubber was ≥ 0.5 and displayed on the

imagery.

2. 5 Application of the Rubber Stand Volume Model

Two methods of applications of rubber stand volume models developed by Suratman

et al. [5] were conducted viz. image segmentation and pixel-based classification

methods. For image segmentation technique, an eCognition’s Version 2.1 software [9]

was used to automatically segment the pixels of the 1999 Landsat TM image. The

volume model was applied to the mean values of all pixels classified as rubber

through a supervised classification process. This produced the predicted rubber

volume for the segment. Rubber pixels within the segment area were then exported

into a shape file (.shp) in ArcView GIS.

2.6 Supervised Image Classification

A supervised classification of the 1999 Landsat TM image was used to produce

general land use/cover types and rubber volume classes. This operation produced a

thematic map with 12 class categories. Pixel-based rubber volume classification was

performed to evaluate the capability of the classifier to categorize rubber stand

volume measured from the field in combination with other land use/cover classes.

Training and testing areas for rubber volume classes were delineated in the image. A

final 12-class map was created from the combination of seven non-rubber classes and

five rubber volume classes: (1) water; (2) forest; (3) oil palm; (4) mixed crops; (5)

grasslands; (6) cleared areas; (7) urban; (8) rubber volume class 1; (9) rubber volume

class 2; (10) rubber volume class 3; (11) rubber volume class 4; and (12) rubber

volume class 5.

2.7 Accuracy Assessment Rubber Models and Land Use/Cover Classification

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The accuracy of the classified products was assessed by comparison with independent

test areas using the standard procedures [10]. This created error matrices, which

encompassed reference pixels with classified pixels. Four criteria were used to assess

the accuracy of the classifications: (1) overall accuracy; (2) user’s accuracy or

commission error; (3) producer’s accuracy or omission error; and (4) Kappa

coefficient = ((overall accuracy-expected accuracy)/(1-expected accuracy)).

3. Results and Discussion

3.1 Rubber Area Model Application

Prior to volume model application, consideration was made to decide whether to use

the area model developed from logistic regression or supervised classification for

producing rubber area masks. For this purpose, the output rubber bitmaps and

classification accuracies produced from both techniques were evaluated (Figure 1).

Comparison of rubber area bitmaps produced from these techniques indicated some

spatial agreements. In terms of accuracy, it was found that the supervised

classification using the maximum likelihood algorithm was superior to the area model.

When refitted with the entire data set, overall, the area model correctly assigned

94.5% of the pixels. However, the model did a better job in predicting non-rubber

(96.3%) than that of rubber (87%). Using the same image (Landsat TM 1999), the

supervised classification produced a higher accuracy of classifying rubber at 96.9%.

Therefore, it was decided that the rubber area map produced from supervised

classification would be used for the volume model application.

3.2 Rubber Volume Model Application

With an image segment-based approach, the application of the rubber stand volume

model in classified rubber pixels was demonstrated. The mean of spectral radiance of

rubber stands were extracted by segments, and then the equation was applied to each

segment. The image segmentation technique resulted in 812 rubber segments, with

segment area ranging from 1.5  14 ha. The mean area of the segments was 3.3 ha,

and the estimated mean of rubber volume derived from the model was 237 m

3

/ha.

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Figure 1. Rubber area maps from the 1999 Landsat TM image of the

demonstration area: (a) output bitmaps of rubber area predicted by area model using a

logistic regression, and (b) thematic map of rubber area produced by a supervised

classification.

Applying the model at the stand level allowed for the extraction of spectral

features to be carried out by segments, which are homogenous in the sense of

their spectral and stand characteristics. In the context of rubber management

planning, the segments could be referred to as rubber estates or rubber small

landholding units. The resulting rubber assessment polygons with six volume

classes (m

3

/ha) estimated from the model are shown in Figure 2 the analysis

demonstrated that the stand attribute model derived from satellite data could be

applied using the image segmentation technique. This provides a useful tool for

estimating average volume within localised areas, plantations, or segments.

Rubber

Non-rubber

2 0 2 4 Kilometres

N

(a) (b)

194

Rubber volume assessment

polygon (m

3

/ha)

< 56.6

56.7 - 149.5

149.6 - 224.9

225.0 - 313.3

313.4 - 439.8

> 439.9

1 0 1 2 Kilometres

N

Figure 2. Rubber volume assessment polygon produced from an application

of volume model and an image segmentation technique superimposed on the

1999 Landsat TM pseudocolour composite (RGB = bands 5, 4, 3) image of the

demonstration area.

3.3 Rubber Volume Classification Accuracy

Supervised classification resulted in a thematic map (Figure 3) and error

matrix (Table 1) consisting of seven land use/cover-class categories

combined with five rubber stand volume classes. The overall accuracy and

Kappa coefficient values were 67.7% and 0.64, respectively. While water

bodies, forests, cleared areas, and urban areas were displayed without much

confusion, however mixed crops, grasslands, and all rubber volume classes

showed high amounts of misclassification. Also, the low accuracy was

attributed to the difficulty in separating grasslands from rubber volume class

1. In particular, 72% (430) pixels belonging to grasslands were misclassified

as volume class 1. Only 18.2% of the pixels (user’s accuracy) were correctly

classified. Major confusion was also observed between mixed crops and

volume class 1. About 58% (417) of pixels belonging to mixed crops were

confused with volume class 1, which resulted in a user’s accuracy of 27.1%

(Table 1). These confusions where the majority of the area of grasslands and

mixed

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crops were occupied by rubber volume class 1 (0 – 75 m

3

/ha). Again, this

result can be attributed to the existence of ground vegetation and low rubber

crown closure in young rubber plantations (3 – 8 years of age for volume

class 1), resulting in similar signatures to grasslands and the undergrowth

components of mixed crops. As expected, due to poor separability, each of

the volume classes recorded only poor to moderately good classification

accuracies. The user’s accuracy ranged from 18.2% (volume class 3) to

71.0% (volume class 1) (Table 1).

Figure 3.

Land use/cover thematic map combined with rubber volume class map produced by a

supervised classification of the 1999 Landsat TM image

Land use/cover and rubber

volume classes (m

3

/ha)

Water bodies

Forest

Oil palm

Mixed crops

Grasslands

Cleared areas

Urban

Volume class 1: 0 - 65

Volume class 2: 66 - 150

Volume class 3: 151 - 225

Volume class 4: 226 - 300

Volume class 5:  300

2 0 2 Kilometres

N

196

Table 1. Confusion matrix of land use/cover and rubber volume classification accuracy by the number of pixels classified correctly in the

thematic map of the 1999 Landsat TM.

Land use/cover

and rubber voume

classes

Pixels classified by class

User’s accuracy

Water

Forest

Oil palm

Mixed crops

Grasslands

Cleared areas

Urban

Vol. class 1

Vol. class 2

Vol. class 3

Vol. class 4

Vol. class 5

Total

Water 664 664 100.0

Forest 10 1,058 24 11 1 46 9 15 48 1,222 86.6

Oil palm 26 685 69 4 4 9 60 1 2 860 79.7

Mixed crops 1 52 195 26 417 10 18 718 27.1

Grasslands 2 8 34 109 10 430 3 3 599 18.2

Cleared areas 637 637 100.0

Urban 15 368 383 96.1

Vol. class 1 5 9 4 1 96 9 9 2 135 71.0

Vol. class 2 10 1 7 1 1 13 38 10 32 54 167 22.8

Vol. class 3 1 23 6 7 20 16 3 12 88 18.2

Vol. class 4 1 1 1 11 1 2 4 54 62 232 53 422 55.1

Vol. class 5 3 4 2 1 1 23 37 124 69 264 26.1

Total 676 1,100 803 344 145 667 374 977 264 164 406 240 6,159

Producer’s accuracy 98.2 96.2 85.3 56.7 75.1 95.5 98.5 9.8 14.4 9.7 57.2 28.8

Notes: The bold values show the correctly classified pixels in each category. Numbers of pixel in the grey boxes were used to highlight accuracy

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comparison between general land use/cover and rubber volume classes.

Overall accuracy =

% 7 . 67 100

159 , 6

69 232 16 38 96 368 637 109 195 685 058 , 1 664

  









           

Overall Kappa coefficient = 0.64

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Rubber volume class 1 was clearly associated with grasslands and mixed crops, and

there was confusion among the five rubber volume classes. However, it is also

interesting to explore how well the classification with multiple volume classes

performed for just separating rubber from non-rubber classes and broader volume

class of rubber. Three approaches were used to investigate these questions.

The first approach was to reclassify the image by omitting volume class 1 from the

classification, reducing the number of classes to 11 classes. While this resulted in

improvements in the overall classification accuracy (67.7% to 76.7%), the user’s

accuracies of mixed crops (27.1% to 69.3%), and grasslands (18.2% to 57.8%), it did

not result in an appreciable increase in all rubber volume class accuracies (table not

shown).

The second approach involved comparing overall rubber volume classification

accuracy to general land use/cover classification (see grey boxes in Table 1). Results

from these analyses indicated that combining all rubber volume classes together

produced an overall user’s accuracy of 91.0% ((980/1078) × 100) and producer’s

accuracy of 47.8% ((980/2051) ×100). The poor overall producer’s accuracy was

attributed to the association of mixed crops and grasslands with rubber volume class 1

as described in Section 5.3.4.3. Combining all classes together except volume class 1

produced 89.2% user’s accuracy ((839/941) × 100) and 78.1% producer’s accuracy

((839/1074) ×100) overall. The main source of error was in separating oil palm and

rubber volume class 2. Subsequently, combining all classes together except volume

classes 1 and 2 produced an overall user’s accuracy of 78.6% ((608/774) × 100) and

producer’s accuracy of 75.1% ((608/810) ×100).

Generally, errors from rubber volume classification were resulted from high natural

variability within volume classes. Also, the high error was likely due to the volume

classes used for the classification being too fine. This caused an overlap of spectral

signatures because the spectral characteristics of the volume classes were not

distinctive enough to be used for the identification and separation of individual rubber

volume classes. As well, the volume classes are a continuum with transition zones

between them. A combination of these factors, in part, may have contributed to the

confusion in determining the volume classes using the maximum-likelihood classifier.

4. Conclusions

This paper shows a comparison of two approaches for applying rubber stand volume

model in an extended area of rubber plantations. They are: (1) the use of a supervised

classification to delineate a rubber bitmap for an application of rubber volume model

based on image segmentation technique, and (2) the use of ground information to

provide training areas for a combined supervised classification of land use/cover and

volume classes. The first approach resulted in 11.7% overall classification error with

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eight land use/cover as compared to an overall classification error of 32.3% for the

twelve classes in the second approach. The classification error using the first approach

was 3.6% as compared to a classification error of 29.0 – 81.8% for the five rubber

volume classes in the second approach. Therefore, for the purpose of predicting

rubber volume classes within a spatial unit, the first approach was preferred.

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Civil Engineering II

2013/3/16 Saturday 10:45-12:15 Room 604

Session Chair: Prof. Mehmet Sahin

ACCMES 158

Modal Analysis of Regular Shear Buildings; an Analytical Approach

Mehmet Sahin ︱Turksat A.S.

ACCMES 159

Critical Direction of Horizontal Load for Maximum Forces in Columns and

Braces for Elevated Water Tanks

Abhay Genu Khandeshe︱Visvesvaraya National Institute of Technology

Ramakant K Ingle︱Visvesvaraya National Institute of Technology

ACCMES 161

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Chih Yuan Chang︱Feng Chia University

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Kalyan Kumar Moulick︱Bengal Engineering and Science University

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Analysis of Factors for Growth of Local Industries and Changes in the

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Yoshikazu Iwasaki︱Osaka Institute of Technology

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ACCMES 158

Modal Analysis of Regular Shear Buildings; an Analytical Approach

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Abstract

The governing dynamic equilibrium equation of N-story regular shear building

witharbitrary top story mass, arbitrary base story stiffness and subjected to base

excitation is given in theform of constant coefficient second order finite-difference

equation. The z-transform method isapplied to the equation to obtain the general

solution for displacement mode shapes. Applying thesecond boundary condition the

result in a nonlinear characteristic equation in which the frequenciesare obtained by

solving it. The general form of the characteristic equation for eigen-frequencies

ispresented and displacement and drift modeshape functions are obtained. All the

modal parameters including modal mass, excitation factor,participation factor, and the

effective modal mass are presented as sum and sum of square of

modaldisplacements.Some special top mass cases is discussed in detail and their

modal parameters are given in the exact analytical form.The method discussed in this

study can also be extended for the other 1-D engineering systems which may have the

same equation of motion, such as repetitive spring-mass vibration system.

Keyword:eigen-analysis, modal analysis, z-transform, shear buildings, repetitive

structures

5. Introduction

The some systems, such as structures, electrical/electronic systems etc., with

manyidentical parts, substructures or subsystems joined together in various forms are

frequently encountered in engineering practice. Examples ofsuch engineering systems

are rotors, monorail tracks, aircraft fuselages with segments, buildings,towers, etc.

These kinds of structures are sometimes named as, periodic, repetitive, identical,

regular,or uniform structures. The periodicity of the substructures makes the structures

easy to analysis in asimplified manner. There are mainly four approaches to analyses

of the periodic structures asmentioned in the Stephen's study[ HYPERLINK \l

"Stephen1999" 1 ]. These are direct, direct field, periodic structure and

substitutecontinuum methods. The direct method is direct solution of the governing

mathematical equations bynumerical methods, such as the matrix methods. The

matrix methods are readily available and widelyused in engineering practice, but, they

can be computationally least efficient and time consuming forperiodic structures. The

direct field method uses finite-differences to relate the displacements oneither side of

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the cell elements. The periodic structure method typically uses a transfer matrix to

relatethe state vector of displacement and force components of on either side of the

generic cell. Lastly, thesubstitute continuum approach can be suitable if the number of

periodic substructures is sufficientlylarge to approximate the structure as a continuum.

Buildings with identical stories at each floor level are well-known examples of

periodicstructures. The shear building model is actually an idealized model where it

assumed that floors arerigid and columns are inextensible so that no joint rotation

occurs at the floor and column connections2][ HYPERLINK \l "CloughPenzien2003"

3 ]4][ HYPERLINK \l "Sahin2008" 5 ]6][ HYPERLINK \l

"WilsonEERIHabibullah1987" 7 ]8][ HYPERLINK \l "Timoshenko1971" 9 ]. This

idealization reduces the number of degrees of freedom since only thelateral

translational degrees of freedoms are taken into account. The eigen -solution of

uniform shearbuildings using direct field method is available in the

literature4][ HYPERLINK \l "Thompson1993" 10 ]5][ HYPERLINK \l "sah1" 6 ].

This study is an application ofdirect field approach using z-transform method to solve

eigen-analysis of the discrete uniform shearbuilding and is to obtain the modal

parameters. However, the formulation can be valid for any one-dimensional periodic

structures havingthe same equation of motion as discussed in this study. Twoboundary

conditions are the top story equilibrium equation and base story zero displacement.

The topstory mass for the boundary condition and base stiffness are selected

arbitrarily to obtain more generalform of the system model including buildings with

soft-story or base isolation systems. Thecharacteristic equation is obtained by

applying these boundary conditions and can be solvedanalytically for certain

boundary conditions otherwise it requires numerical solution method.

Generally, a dynamical system consisting of N-degree of freedom system may

require thesolution of a Nth order polynomial characteristic equation or the

eigen-solution of NxN matrix.The z-transform method is widely used in digital signal

processing, digital control,communication field of electronic engineering. The

transformation is discrete form of Laplacetransformation and makes it suitable

solution method for discrete systems as compared to Laplacemethod for continuous

systems11]. There are numerous studies, which are toomany to mention all them here,

related to structures with identical subsystems[ HYPERLINK \l "Jennings1997"

2 ]4][ HYPERLINK \l "Sahin2008" 5 ]12][ HYPERLINK \l "MeirovitchEngels1977"

13 ]. Meads12] summarizes and reviews all the studies regarding wave propagation

and response analysis of periodic structures until 1995. Stephen[ HYPERLINK \l

"Stephen1999" 1 ] uses periodic structure and substitute continuum approach to

study frequency analysis of pin-jointed one-dimensional framework and compare

various continuum models with actual FEM model frequencies. Karpov et al.14] use

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discrete Fourier transform method for thestatic analysis of repetitive lattice structures.

Meirovitch[ HYPERLINK \l "MeirovitchEngels1977" 13 ] applied the z-transform

method to the matrix difference equation to obtain the general form of response for

the periodic structures. This study is an application of the z-transform method to the

repetitive shear building with arbitrary top story mass and base stiffness.

6. Formulation and Solution

Consider N-story uniform shear building with equal story masses, lateral stiffnesses,

and heights are shown by m, k, and h respectively (Fig.). However, the top story mass

and base story stiffness are assumed to be arbitrary to consider more general case for

the various boundary conditions. The origin of the index variable n starts from the top

of the building and ends at the base. The base story stiffnes is multiple of regular mass,

i.e. and relation between top story mass and regular mass is given as

. The building is assumed to be standing on rigid foundation and

subjected to a ground excitation . The governing equilibrium equation for n-th

floor level at time t can be written in constant coefficient second-order finite-difference

form as

(1)

where are backward, forward and central difference operators

respectively.The first boundary condition is the force equilibrium at the top of

building. The second boundary condition is base displacement which is assumed to

have zero displacement, i.e. .

For free-vibration analysis, the displacement can be separated into the

displacement mode shape function and time dependent function by using

the separation of variables method.

(2)

In the Eq. 2, ω is the vibration frequency and φ is the phase angle. Then, the

governing equation of free-vibration for modal displacement shape function becomes.

(3)

where is normalized frequency of the shear building. The boundary

condition at the top story level includes the top story mass which can be taken

arbitrarily for more general case analysis. Two common different cases for the top

story mass will be considered in detail, the first case is all masses including top

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masses are the same i.e. m0 =m, the second case is the top story mass is half of the

other story masses, i.e. m0

=m/2. The latter case is just for simplification in the

formulation and may be suitable for discretization of some real continuous

bars[ HYPERLINK \l "Thompson1993" 2 ].

Fig. 1