EXPERIMENTAL RESEARCH OF CREEP, RECOVERY AND FRACTURE PROCESSES OF ASPHALT CONCRETE UNDER TENSION

Alibay Iskakbayev[1], Bagdat Teltayev[2a)], Femistokl Andriadi[2],
Kayrat Estayev[2], Elena Suppes[2] & Ainur Iskakbayeva[3]
[1]*al-Faraby Kazakh National University, Almaty, 050040, Kazakhstan*
[2]*Kazakhstan Highway Research Institute, Almaty, 050061, Kazakhstan*
[3]*Caspian University, Almaty, 050012, Kazakhstan*

Summary There are given results of experiments over fine grained asphalt concrete on mode of direct tension under constant stress, staged and cyclic loading at temperature of 20°C. Curves of creep and long-term strength have been constructed. Essential influence of magnitude, duration of loading and resting between loadings on asphalt concrete failure time has been stated. Only 6-7% of strain recovers after removing of the load.

INTRODUCTION

Asphalt concrete is one of the main materials to construct road pavements. Mechanical properties of asphalt concrete depend on temperature, magnitude and duration of loading [1]. Under actual road condition, load magnitude of vehicles' wheels on asphalt concrete pavement surface and loading duration change in wide range. Therefore practical importance is determination of the mechanical behavior of asphalt concrete taking into consideration changes in mentioned above factors.

In this paper there are presented results of experiments over samples (size: 5x5x16 cm) of fine grained asphalt concrete prepared using bitumen (grade of 100-130) on scheme of direct tension in different loading regimes at 20 °C temperature. 70 samples of asphalt concrete were tested.

CONSTANT STRESS

Testing under constant stress (creep) is one of the basic methods for determine behavior of viscoelastic material [2]. Testing of asphalt concrete samples was carried out on special constructed equipment. Obtained results showed that under all stresses asphalt concrete samples were failed. Asphalt concrete creep curves have three characteristic sites (Fig.1): the site I of unstabilized creep with decreasing rate, the site II of stabilized creep with constant (minimum) rate and the site III of accelerating creep with increasing rate which precedes failure. Average relative durations of these sites are equal to 13 %, 63 % and 24 % respectively.

Constructed curve of asphalt concrete long-term strength is satisfactorily approximated by power function. Stress change per one order causes changes in failure time of tree orders.

STAGED LOADING

Under actual road conditions vehicles with different weight parameters move on roads. Their axial loads vary in wide range. Sequence of its application also essentially changes. Therefore there were tested asphalt concrete samples according to staged loading scheme to estimate influence of loading sequence and its value on asphalt concrete failure.

The first sample was loaded by stress equal to 2.29 kg/cm^2 (39.4 % from strength) during 40 seconds (loading rate 0,0573 kg/(cm^2·s) which had not changed for 60 s. Then with the same loading rate the stress was reduced till 1.57 kg/cm^2 which was constant till the sample failure. The sample failure time was 1987 s.

The second sample was loaded firstly by stress equal to 1.7 kg/cm^2 (27.0 % from strength) with the same loading rate which was constant during 60 s. Then the stress was increased till 2.29 kg/cm^2 with the same loading rate which was constant till the sample failed. The sample failure time was 1024 s.

There was established that changes in small and big tension stresses sequences essentially influence on the asphalt concrete failure time. In the case when the sample was firstly loaded by big stresses and then by small ones the failure time increases almost for two times than the sample was loaded firstly by small stresses and then by big ones. This fact can be explained by the fact that in the first case the duration of acting of big stress is essentially less than duration of acting of small stresses.

CYCLIC LOADING

There are relaxation periods with different durations between loading sequences on roads. The sample of asphalt concrete was tested according to the certain scheme to estimate relaxation effect. Firstly the sample was loaded by stress equal to 1.38 kg/cm^2 (23.8% from strength) with rate equal to 0.0626 kg/(cm^2·s) which was constant during 120 s. Then

a) Corresponding author. Email:bagdatbt@yahoo.com.

the sample was unloaded fully with the same rate and it rested during 300 s. That regime of loading-unloading-rest was carried out five times. The stress was constant after the 6th time of loading till the sample failure (Fig. 2). Next sample of asphalt concrete was tested under constant stress equal to 1.38 kg/cm^2 till it failure. The times of the samples failure were 14 916 s and 5 836 s respectively.

LOADING WITH CONSTANT RATE

It was established that the asphalt concrete under investigated regimes of loading and temperature has essential plasticity: only 6-7% of strain recovers; relaxation between serial loadings essentially increase the failure time - five time relaxation with 300 s duration of each increased the failure time for 2.6 times.

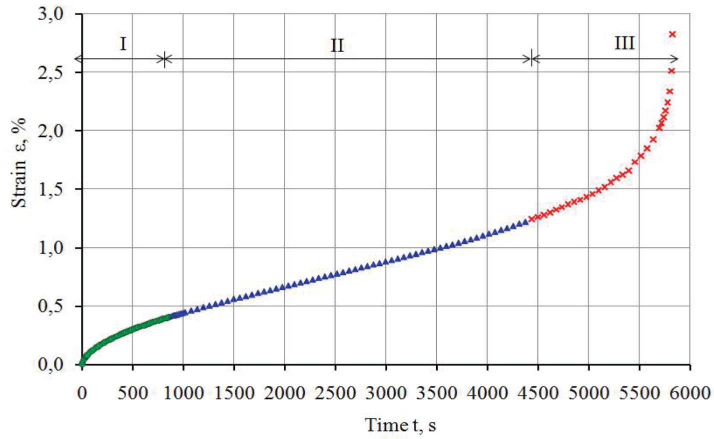

Fig. 1 Creep curve of the asphalt concrete

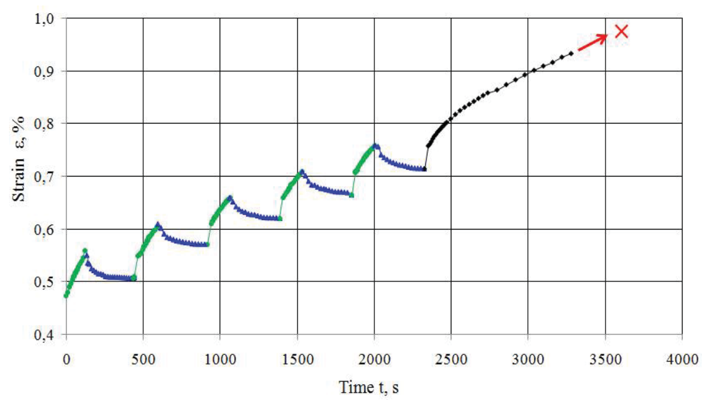

Fig. 2 Curve of the asphalt concrete deforming at staged loading

Next samples of asphalt concrete were tested by loading with constant rate till failure. The results showed that dependence of strain from stress is nonlinear. The influence of loading rate on asphalt concrete strength was found.

CONCLUSIONS

Experimental research of fine grained asphalt concrete samples at different regimes of loading showed, that: a creep curve has tree stages of deforming; the curve of long-term strength is discribed by the power function; at big loads dependence of stress from strain is nonlinear and plasticity is occurs.

References

[1] Levenberg E.: Modelling asphalt concrete viscoelasticity with damage and healing. International Journal of Pavement Engineering. 2015: 1-13.
[2] Cristensen R.M.: Theory of viscoelasticity: an introduction, Academic Press, NY 1971.