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LABORATORY TESTING OF ASPHALT BELTS WITH THE INFLUENCE OF TEMPERATURE

LABORATORNÍ TESTOVÁNÍ ASFALTOVÝCH PÁSŮ S VLIVEM TEPLOTY

Abstract

This paper deals with laboratory testing of asphalt belts shear response at different temperatures using temperature controlled room. Test results of asphalt belts shear response, resp. depending derived there from, are then used to develop new computational methods for assessment of structures with applied sliding joint. Sliding joints are used to reduce friction in foundation structures, concrete floors or eg. for pre-stressed foundations for reducing friction between the foundation and the subsoil during pre-stressing.

Keywords

Sliding joint, shear response, asphalt belt, temperature controlled room.

Abstrakt

Tento příspěvek se zabývá laboratorním testováním smykové odezvy asfaltových pásů za různých teplot s využitím klimatizační komory. Výsledky smykové odezvy asfaltových pásů získané laboratorními zkouškami, resp. závislosti z nich odvozené, jsou dále využívány při tvorbě nových výpočetních metod pro posuzování přetvářejících se konstrukcí s aplikovanou kluznou spárou. Kluzné spáry se s výhodou využívají pro snížení tření v základových konstrukcích, při provádění betonových podlah nebo např. při provádění dodatečně předpínaných základů pro snížení tření mezi základem a zeminou v průběhu předpínání.

Klíčová slova

Kluzné spáry, smyková odezva, asfaltový pás, klimatizační komora.

1 INTRODUCTION

The method of decreasing in shear stress in footing bottoms of rheological sliding joint applications is effective and easily executable in practice. Sliding joints are usually formed by a

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melted or loosely laid asphalt belt on a levelling concrete layer or by mastic asphalt or plastic foil. Current methods [1] of the sliding joint designs are, as far as still new, continuously developing materials are concerned, no longer sufficient and they can be used for indicative calculations only. The correctness of the rheological sliding joint design is conditioned mainly by knowledge of asphalt belt mechanical response at shear loading effecting for a long time because in the majority of cases, constructions are mainly influenced by long-lasting reshaping. The measuring device was assembled for this purpose at the Faculty of Civil Engineering VŠB, and in 2007 the first measuring works were carried out for various kinds of new asphalt belts [2]. In the thesis, the author also drew the attention to the fact that behaviour of the asphalt belt was influenced by the temperature of the structure and the ambient temperature to a great extent. With the view to this fact, a temperature controlled room was constructed in 2010 in order to set the ambient temperature within -20 thru +40 °C.

Currently, measuring work is being carried out with oxidized asphalt belts of one type (business name IPA V60 S35, [3] and [4]) at various temperatures and various values of shear loading. Measuring of a wide range of state-of-the-art materials is, however, supposed. A database of mechanical properties is being created based on the measured deformations of the asphalt belts. The database should form the basic data set for proposal for new calculation methods and computations in the future.

2 LABORATORY TESTING

2.1 Testing Device

Steel structures designed for this purpose and constructed in 2007, see Fig. 1, was used for introduction of both vertical and horizontal loadings into a test sample (a concrete block with two asphalt layers).

Fig.1: Steel test device

A special temperature controlled room for creating of the constant-temperature environment was then constructed. The steel structure of the testing device was inserted in. See Fig. 2.

Fig. 2: Testing device placed in the temperature controlled room

2.2 Measuring Procedure

At the first stage, the test block is loaded vertically only. After 24 hours, a horizontal device is introduced, and electronic sensors measure the shift of the loaded concrete block at specified time intervals for next 6 days. The measuring procedure is detailed in another thesis [2].

2.3 Test Body

The test body consists of three concrete blocks sized 300×300×100 mm and two sliding joints in between. These sliding joints are filled with the tested material. Currently only one kind of material is being tested [3], [4], and only the combination of various loading values and ambient temperature is being changed.

2.4 Loading

With the view to the fact that the measuring is a time consuming activity (one measuring lasts for 7 days), 6 loading combinations were chosen – two values of vertical loading and three values of horizontal loading were mutually combined. The individual combinations are mentioned in the table 1. The specific values of the introduced loadings are derived from the real stress values and shift speed values which may arise in the footing bottom. The vertical stresses which may usually arise in the footing bottom are considered within the interval of 100 thru 500 kPa, while, with the view to the above-mentioned time-consumption of the measuring, the values of 100 and 500 kPa are tested. The horizontal stress is considered so that the order deformation speed value measured in the middle concrete block corresponds to the deformation speed values in the real structure.

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Tab. 1: Measured combinations of vertical and horizontal loadings

Measured combinations	Vertical loading [kPa]	Horizontal loading [kN]	Remark
1	500	0.62	see Fig. 3
2	500	0.95	see Fig. 4
3	500	2.00	see Fig. 5
4	100	0.62	see Fig. 6
5	100	0.95	to be measured
6	100	2.00	to be measured

3 MEASURING RESULTS

The measuring results are included in the tables and graphs, see Fig. 4 thru 6, and then other dependences are derived, see [5] and [6]. Knowing these issues, one can define friction parameters without any greater difficulties. These friction parameters can be easily prescribed in some commercial software programmes and thus they can be applied in common design practice. The calculation methodology of the friction parameters of the sliding joints from the laboratory tests is detailed in the thesis [2].

With the view to the fact the the new measuring work resumes the previous measuring work performed in 2007, a check measurement was carried out at first, and the results were compared to the original measuring work which had been carried out at the common laboratory temperature (approximately 20 °C). By way of illustration, the values of the original measuring work are marked in the graph in Fig. 5 with a dash-dotted line. It follows from the graph that the values of the original and the new measuring work are conditionally mutually corresponding. A certain deviation of the curve is caused by the fact that the temperature controlled room in the new measuring work provided a constant temperature all over the measuring work, whereas in the original measuring work a certain deviations from the mentioned temperature could occur. Another reason is also the change in the measuring device – originally the shift was measured using mechanical sensors and values were deducted and recorded manually, whereas now shift values are recorded automatically using electronic sensors at exact and regular intervals. Last but not least, this deviation is also caused by the fact that both the measuring works (both the new one and the original one) was carried out only once and it is not an average of several measuring works.

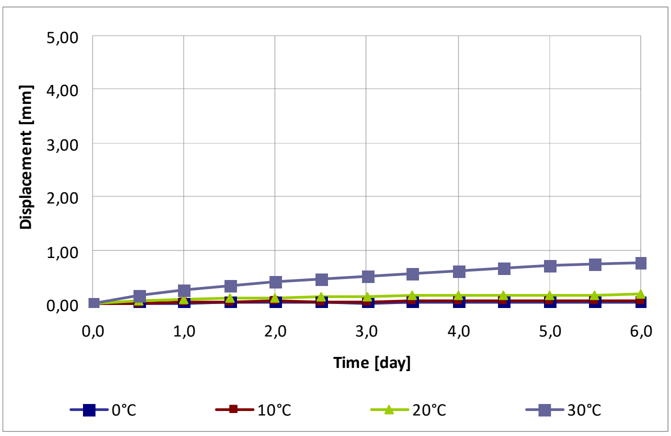

Fig. 3: Combination of vertical force V=500kPa and horizontal force H=0.62kN

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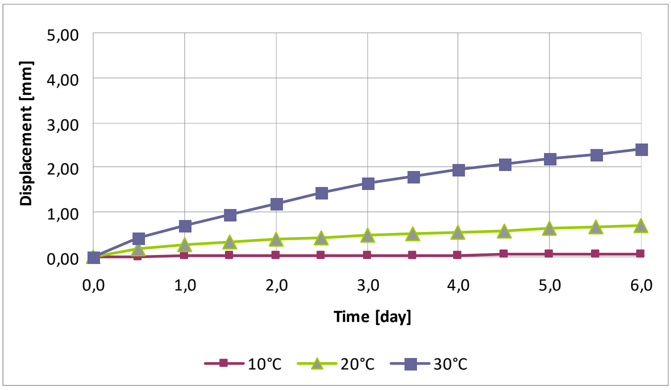

Fig. 4: Combination of vertical force V=500kPa and horizontal force H=0.95kN

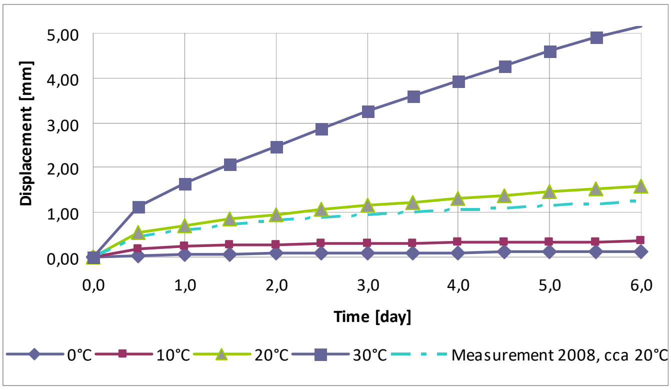

Fig. 5: Combination of vertical force V=500kPa and horizontal force H=2.0kN

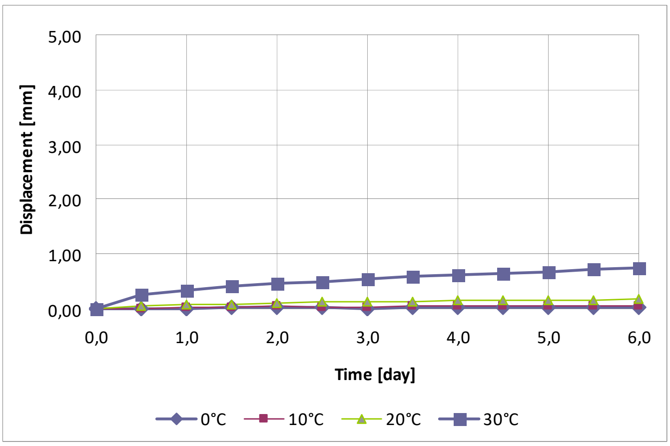

Fig. 6: Combination of vertical force V=100kPa and horizontal force H=0.62kN

4 CONCLUSION

It arises from the above-mentioned measuring works that the shear response of the asphalt belts, as it was supposed before, is influenced by the temperature to a great extent. In common, it can be said that there are greater deformations at higher temperatures and vice versa. While proposing new calculation methods, it is, therefore, necessary to take this fact into account and to include the influence of the expected temperature in the structure and its immediate surroundings into the calculation. If the temperature influence in the structure is taken into account, deriving of the necessary relations will be more complicated and more demanding. The resultant relations, however, will describe real behaviour of the respective material in the structure better.

In this article, only results of the measuring works which have been executed so far are presented; however, the measuring work for one kind of the oxidized asphalt belt is still being carried out and even other state-of-the-art materials which can be used for creation of sliding joints are going to be measured successively. Formation of the sufficiently extensive database of the mechanical properties of the asphalt belts and other materials is, unfortunately, a time consuming activity not only due to the wide range of product, but also due to the effort to take the long-term effects of the loading into account. In the future, the database could be a basis of methods for practical design of constructions with sliding joints.

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