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MULTI-LAYER RHEOLOGICAL SLDIING JOINT IN THE FOUNDATION STRUCTURES

Abstract

Sliding joints are often used to reduce effects of shear stresses in footing bottom. This stresses can be rooted in subsoil (effect of undermining) or they can arise in structure directly (shrinkage and creep of concrete, pre-stressing) and sliding joint can be used for both of them. The asphalt belts are used to create sliding layer between subsoil and construction in most of cases. The laboratory tests are carried out to verify their behavior by shear loads at the Faculty of Civil Engineering VSB TUO. This paper deals with testing multi-layer sliding joint and how the increasing number of belts influences reducing shear resistance in the sliding joint.

Keywords

Sliding joint, asphalt belt, undermining.

1 INTRODUCTION

In order to better using of potential of this method in practice it is necessary to know shear response of asphalt belt at the known speed of deformation (deformation of the subsoil or structure). For this reason it is carried out set of laboratory tests to verify asphalt belts properties at the horizontal load. It would be difficult to ensure constant speed of asphalt belt deformation therefore speed of deformation is monitored at given shear stress. Shear stress in the sliding joint in the concrete structure with sliding joint can be established in dependence on speed of deformation with using results from tests. The speed of deformation can be obtained from mining conditions or shrinkage or creep models.

Basic assumption to use of multi-layer sliding joint is that the sliding joint can carry larger deformation in the sliding joint and also greater reduction of unpleasant effect of frictional forces on structure than in the case of one-layer sliding joint. In next chapters will be described the basic principle of the test and it will be presented some concrete results from these tests of multi-layer sliding joint.

2 BRIEF DESCRIPTION OF THE LABORATORY TESTS

The aim of these tests is to simulate behavior of asphalt belts which create sliding joint in the foundation structure. The basic principle of the sliding joint function is shown on the Figure 1.

The test sample consists of three concrete blocks 300x300x100 mm and two sliding joint between these blocks (Figure 2). These sliding joints are filled with testing material (one loosely placed asphalt belt was tested in most cases; but the first results from testing of multi-layer sliding joints are presented in these paper).

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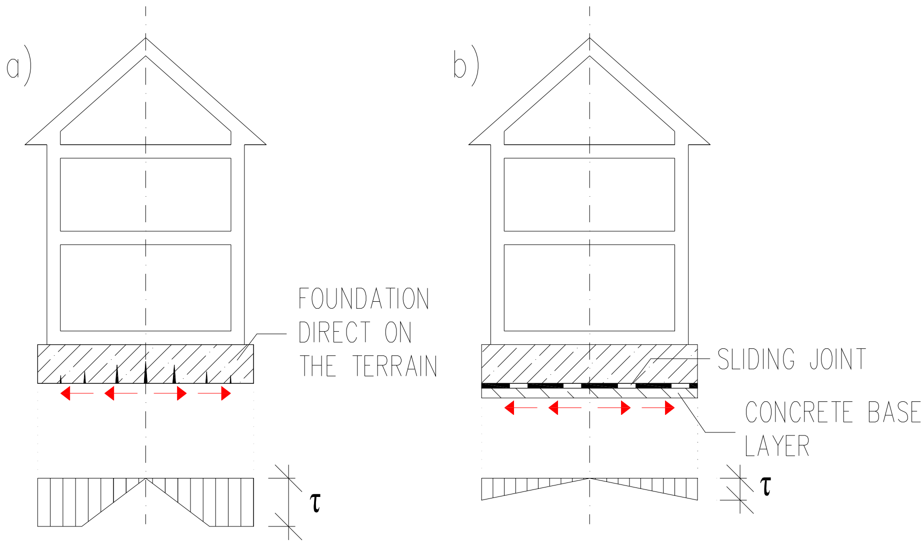

Fig. 1: Basic principle of function of sliding joint in the structure

The vertical load *V* which represents load from superstructure is introduced into the test sample (Figure 2) in the first phase. The middle block of test sample is loaded after 24 hours with horizontal force *H* which infers constant shear stress in sliding joints between blocks and causes horizontal deformation. The deformation is monitored during the tests. The test is finished after six day since the introducing of horizontal load when is also achieved constant speed of displacement.

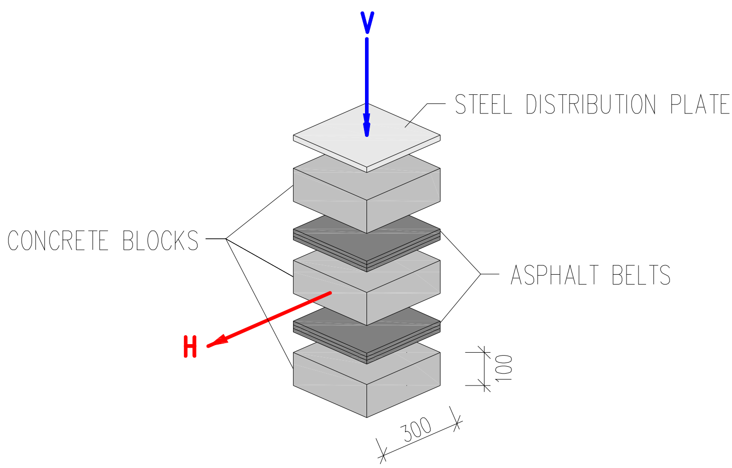

Fig. 2: The test sample

The steel equipment which is shown on the Figure 3 was used to introducing vertical and horizontal loads into test sample.

Vertical load is inferred through steel plate using hydraulic press and horizontal load is introduced using basket with weights which is fixed to middle concrete block and low and top block are firmly fixed. The test equipment was placed into air-conditioned room to ensure effect of ambient temperature. Other information about the tests and test results can be found for example in [1, 2, 3, 4].

Vertical stresses which can arise in foundation bottom are considered in the interval 100 to 500 kPa and only two extreme values 100 and 500 kPa are tested due to time-consuming. Horizontal load are considered so that the speed of deformation measured on the middle concrete block would respond to speed of deformation on the real construction. Two values of shear stress were selected – 5.28 kPa and 11.1 kPa.

Each set of measurement is carried out at least for two temperatures (usually 10 °C and 20 °C). On the whole 8 measurements are carried out for each type of asphalt belt. The test results can be used to numerical modeling using FEM [5-17]. Example of application of sliding joint in the practice can be found in [18, 19].

Fig. 3: The steel test equipment

3 TESTING OF MULTI-LAYER SLIDING JOINT

The idea of testing multi-layer sliding joint is based on the assumption higher deformation in the sliding joint by the same values of the shear stress. That means also lower shear stress on the contact surfaces of structure where sliding joint will be applied.

The principle of the test is almost the same as classically test described in previous paragraphs. Concrete blocks have lower height (90 mm) to get whole test sample into test equipment. Another difference is in count of asphalt belts between concrete blocks.

The elastomeric modified asphalt belt without spreading with a thickness of 3.4 mm and a weight of 4.0 kg/m^2 was chosen for the first measurement of multi-layer sliding joint. The basic set of measurement has been already available to this belt. Each sliding joint was created using three loosely placed square of asphalt belt at the dimension 300x300 mm in the below presented results.

3.1 Comparison of the results between one- and multi-layer sliding joint

Comparison of the total deformation in the case of using one or three same belts is shown on the Graph on the Figure 4. In this case tit is elastomeric modified asphalt belt without spreading with a thickness of 3.4 mm and a weight of 4.0 kg/m^2. It is clear from the graph that the assumption of higher deformation by using more layers was correct and more belts in the sliding joint have result also higher deformation and lower shear response.

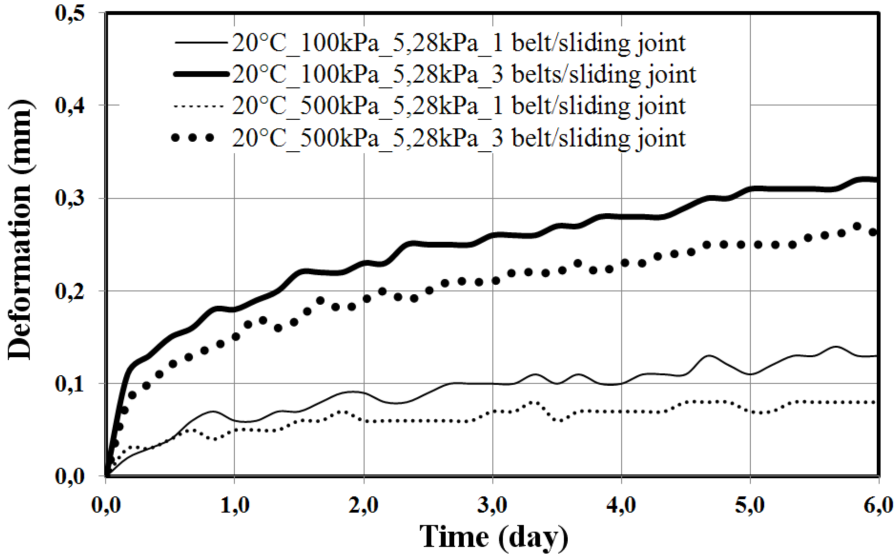

Fig. 4: Comparison of total deformation for one and multi-layer sliding joint

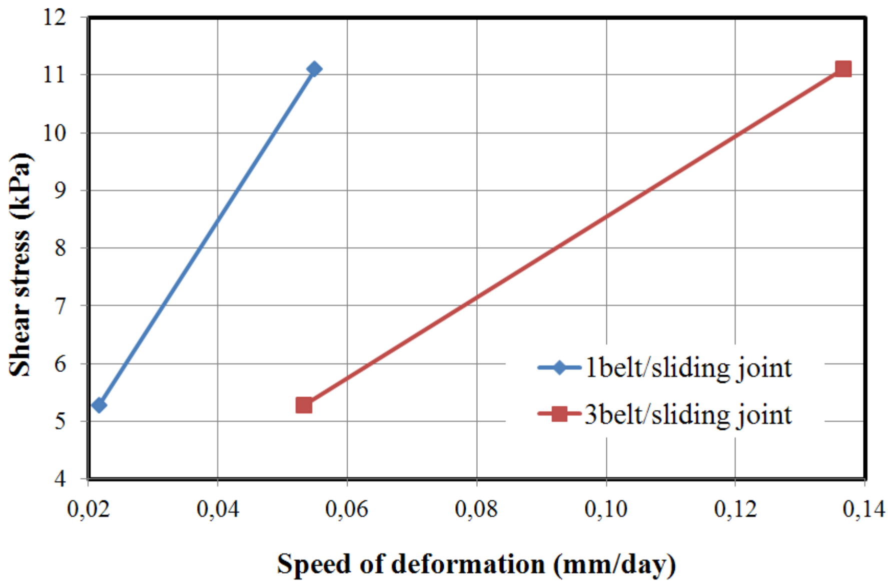

Fig. 5: Comparison of total deformation for one and multi-layer sliding joint

Real shear response for concrete asphalt belt (or layers) can be determined from the graph on the Figure 5 for specific cases in practice (for elastomeric modified asphalt belt without spreading with a thickness of 3.4 mm and a weight of 4.0 kg/m^2, temperature 20 °C and vertical pressure 100 kPa) in dependence on speed of deformation of terrain or speed of deformation of structure. These are variables known from mining condition (in the case of undermining) or from creep and shrinkage models. It is clear from the graph on the Figure 5 how much different is interval of incurred deformation at the same interval of shear stress (from 5.28 kPa to 11.1 kPa).

6 CONCLUSIONS

The first tests of sliding joint created with three asphalt belt in one sliding joint were carried out. Current results show that it can be obtained higher deformations and also lower shear response in the sliding joint than with only one belt with increasing of number of asphalt belts. It can contribute to increasing undesirable stress more significantly and this method can be used also for higher horizontal load than in the case of one layer sliding joint. It is necessary to make other measurements for other types of asphalt belts or for different number of belts to allow making results about advantages and disadvantages of multi-layer sliding joint.

Creating of the rheological sliding joint in the multi-layer variant introduce possibility to higher increasing of unpleasant effect of horizontal loads (undermining, creep or shrinkage) than in the case sliding joint created from one layer of asphalt belt.

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