PETRIK P.M.

Civil Engineering Research Institute, Bratislava, Chechoslovakia

Laboratory study of tensions in slabs and deformations of reinforced earth works

Etude en laboratoire des tensions dans les armatures et des déformations des ouvrages en terre armée

RESUME

La communication présente l'évaluation des résultats des études en laboratoire conduites à l'Institut du Génie Civil Bratislava, Tchécoslovaquie /VÚIS/. A l'aide de modéles en rouleaux, du type Taylor-Schneebeli, on a déterminé l'influence du mode d'armament des murs de soutènement - type "terre armée" - sur les tensions dans l'armature et sur les déformations d'un ouvrage de soutènement.

INTRODUCTION

In the contribution the evaluation is presented of laboratory tests results using pin models for determining the influence of the mode of reinforcing the backfill of retaining walls anchored into the reinforced soil on the development of tensile stresses in the reinforcement as well as on the deformation mode of the retaining construction. For the stresses determination strain gauges engineering was used. For tracing retaining constructions stereophotogrammetry was applied; the evaluation of results was made by the aid of a computer.

DEVELOPMENT OF REINFORCEMENT STRESSES

In the first series of model tests the connection was investigated between the retaining wall´s backfill reinforcement length and the development of reinforcement stresses. The lay out of the various model modes is given in Fig. 1, line a. The following reinforcement lengths were used alternatively: 1.94 H, 1.20 H, 0.87 H, 0.54 H, where H is the retaining wall height. The places for the various strain gauges are given by points on the reinforcements. By the aid of measurement results of the various forces point sensors, idealized isostats of the backfill reinforcement tensile stresses were produced, which are given in Fig. 1, lines b, c, d.

Line b represents reinforcement tensile stresses arising at loading the retaining wall backfill by the weight of the backfill, line c represents isostats at uniform loading of the retaining construction surface by the force 200 N, which is roughly equivalent with the weight force of one third part of the backfill. Line d represents isostats of backfill reinforcement tensile forces at an uniform load of the backfill surface by the force 600 N, which is roughly equivalent with the weight force of the entire backfill.

By the results analysis of a series of laboratory tests, informatively represented on Fig. 1, it is possible to obtain the following notion about the connection between the lengths of separate reinforcements and their stress in dependence on the loading conditions of the reinforced backfill:

a/ The strain field of the backfill has a maximum homogeneity if the reinforcements length is slightly greater than the high of the retaing construction /L=1.2 H/. This is caused by the optimum yielding and adaptibility of the construction as well as by sufficient reserves of internal forces moment equilibrium. The zones of maximum tensile stresses appear in the center of the retaining construction´s footing.

b/ By the prolongation of the reinforcement above the optimum value /$L \gg 1.2$ H/, the construction becomes rigid, with minimum deformations. The rigidity of the system is

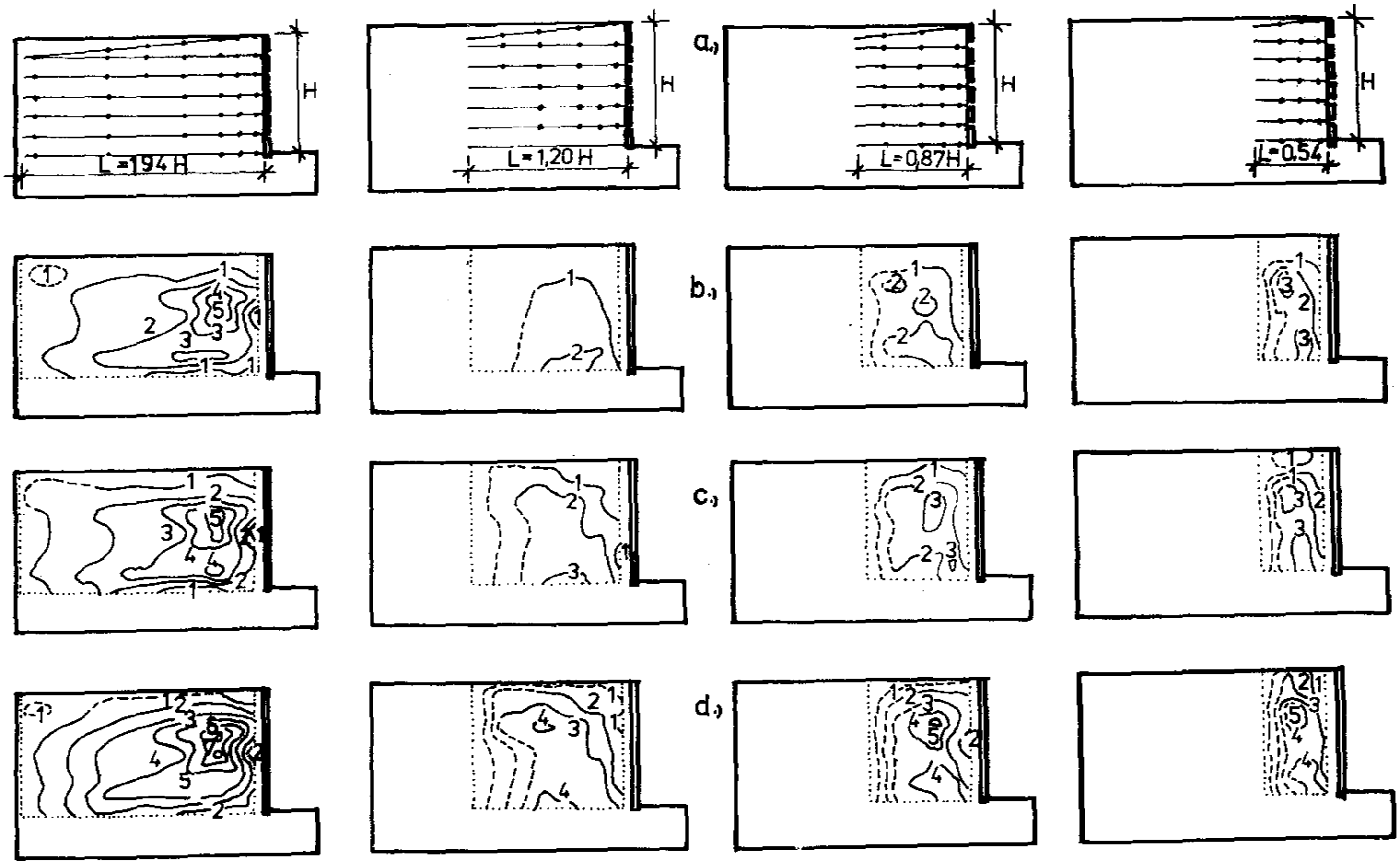

Fig. 1. Development of reinforcement stresses. a/ Models lay-out scheme, b/ Tensile forces isostats in reinforcements at loading the model with the backfill´s own weight c/ After uniform surface loading increase by the force of 200 N, d/ After uniform surface loading increase by the force of 600 N.

created by a relatively large growth of in - ternal tensile stresses. The construction approaches mostly the steady state according to the terminology of soil pressure.
c/ By shortening the reinforcement below the optimum value /L $<$ 1.2 H/, intrinsic tensile stresses growth of the construction is crea- ted. The formation of two tension maxima zo- nes appears very explicitly. The first ten- sile center occurs in the center of the top third of the construction and is created by the successive mobilization of sliding for- ces. The second tensile center is built up in the middle point of the retaining con - struction´s foundation joint. The entire construction is already yielding, but local mobilization of sliding forces occurs. At shortening the reinforcement under the admi- ssible margin, the sliding forces create so large reinforcement tensile stresses zone that the construction crashes down in con - sequence of the insufficient anchoring length of the reinforcement and loss of stability.
d/ Near the face of the retaining wall the reinforcement´s tensile stress diminishes at an arbitrary length of the reinforcement.
e/ If the reinforcement length complies with the relation L $<$ 1.2 H, the tensile stress maximum occurs in the center of the rein- forcement. With reinforcements longer than 1.2 H, the tensile stress maxima occur rough- ly in the distance of 0.5 H from the con- structions face.
f/ With retaining constructions, the length of which is L $<$ H, the function of the re- inforcement´s anchoring part shows oneself explicitly. The length of this anchoring, roughly vertical, zone is informatively one fifth of H.
g/ The mobilization of the failure zone in the backfill of the retaining construction proceeds along a vertical line in the dis- tance of 0.3 to 0.5 H from the face.At load- ing the construction the failure zone in - clinates successively.
h/ The reinforcements are not stressed most- ly at the face of the construction, where, in consequence of the backfill´s deformation, already a pressure near the active one is acting,but inside the construction, where someone of the steady state pressure values is present.

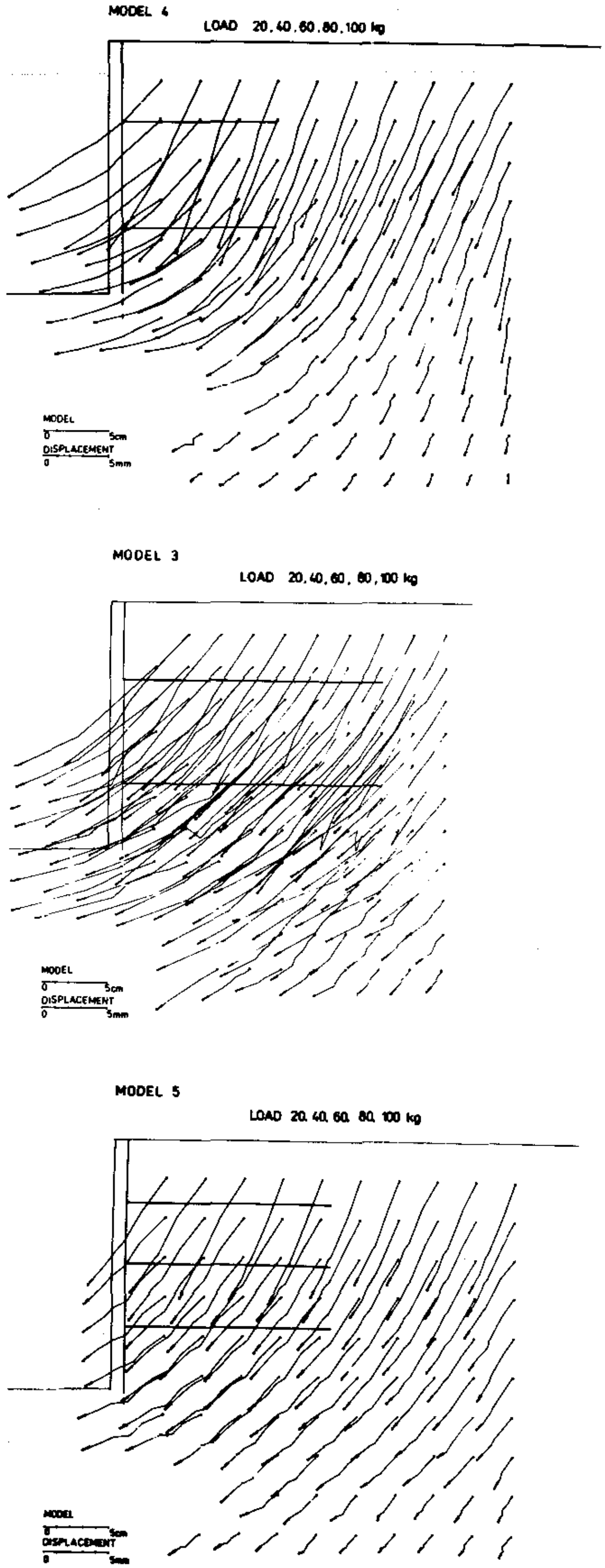

Fig. 2. Displacement vectors of variously reinforced backfills of the retaining construction at uniform loading.

DEFORMATION OF BACKFILL REINFORCED IN VARIOUS MODES

The deformation mode of reinforced bulk material backfill was investigated by the aid of 400 pins placed on the model. Own motions of the deforming environment was registered stereophotographically by fixed cameras. At the registration of deformations also the consolidation of environment was taken into account. From a series of model measurements a small example is shown on Figs. 2 to 4. On the various models the level of reinforcement was alternated as well as the backfill reinforcement´s length. The reinforcement´s

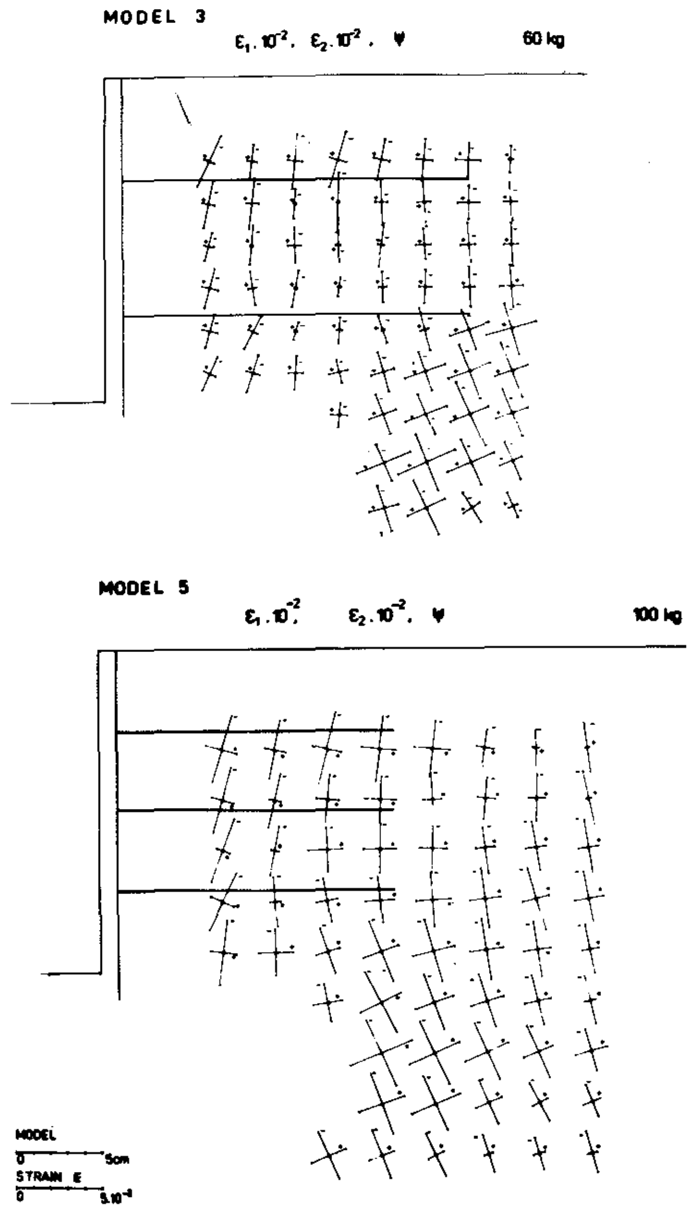

Fig. 3. Fields of deformation main axes for variously reinforced backfills of retaining constructions.

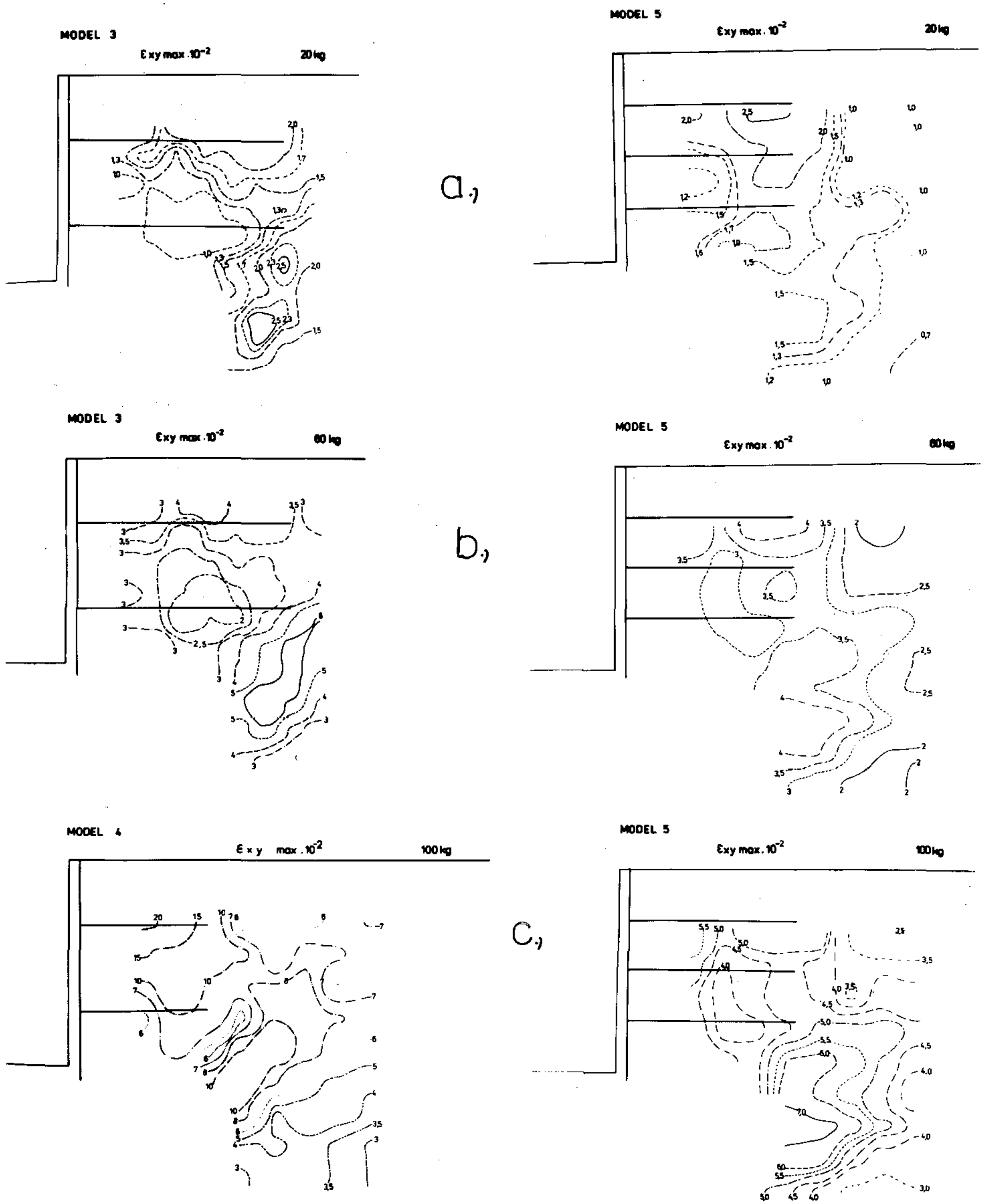

Fig. 4. Isoline fields for maximum shearing deformation of variously reinforced backfills at uniform loading of the constructions surface by a load with the mass: a/ 20 kg, b/ 60 kg, c/ 100 kg.

length was in the range of L = 0.63 to 1.05 H. The backfill was reinforced in two or three layers. On Fig. 2 the vectors are shown of some models dislocation at a various le - vel of uniform load increassing of the re - taining construction surface. By the compa- rison of the vector field of various models presented on Fig. 2 it is evident that by the increase of the reinforcement degree of the retaining construction´s backfill, mainly the horizontal component of the vector field of the reinforced backfill displacement is substantially decreasing. Again, the increa- se of the construction´s rigidity at increa- sing the backfill´s reinforcement degree is being confirmed.

On Fig. 3 the field of main axes of deforma- tion are compared for variously reinforced backfills of retaining constructions. One can see that by increasing the level of reinforcement, no principial change of main deformation axes inclination occurs for the various points of the deforming backfill field.

On Fig. 4 we present the isoline fields of maximum shearing deformations for variously reinforced backfills of retaining construc- tions at a various level of the construc - tion´s surface loading. By mutual of vari- ous models on Fig. 4 one can see that due to the increase of the backfill reinforce - ment level a substantial reduction of planes with shearing deformation is resulting. At loading the surface of the construction with one fourth of the backfill mass, increasing the reinforcement by 50 %, a reduction of shearing deformations of the backfill by 15 % takes place. At loading the surface of the construction with three fourth of the backfill mass, increasing the backfill rein- forcement by 50 %, a reduction of shearing deformations of the backfill by 25 % is re- sulting. At loading the surface of the con- struction with 1.25-times the backfill weight, increasing the backfill reinforce - ment by 50 %, a reduction of shearing defor- mations of the backfill by more than 50 % takes place.

CONCLUSION

In the first series of model tests the con- nection was investigated between the retain- ing walls backfill reinforcements length and the development of reinforcement stresses. According this measurements the strain field of the reinforcement of the fill has a maxi- mum homogenity if the reinforcement length is slighty greater than the height of the retaining construction.

The deformation mode of reinforced fill of the retaining constructions was investigated stereophotographically. According the analy- ses of the vector fields of models, it is evident by the increase of the degree of the fill reinforcements, mainly the horizontal component of the strain vector field is sub- stantially decreasing. Due to the increase of the backfill´s reinforcement level a sub- stantial reduction of planes with shearing deformation is resulting in the bacfill of the retaining construction.