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The Study of Failure Mechanism of Reinforced Soil under Strip Foundation by PIV Method

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ABSTRACT

In the history of the technology of building materials, soil as a mass with shear and compressive strength is well known but not much resistance stretching. To compensate for this deficiency in the soil of the materials as a kind of Geosynthetic reinforced are usually are used. The main objective of this study reviews how to change to forms in soil and its mechanisms can be disruptive. In order to study the pattern of change in soil and created the following forms and how to influence it is armed on the laboratory scale model is also disruptive and physical features (speed measurement of particle image) is used. According to the obtained results were observed due to the tendency of loose dirt to the density, soil elements relative to the following meeting of the Conference, much less. As well as the effect of the angle number placement on the amplifier elements and elements was investigated. View was that by increasing the number of layers is a meeting of the armed elements of the territory against non-State armed groups sought the meeting to have been armed with a layer mode and more. According to the angle of the anchor elements relative to the horizon can be seen that the level of fissures created in the armed mode with two other more than in two layers, in the direction of the longitudinal and cross-section has been extensive.

Keywords: Reinforced soil, Physical modeling, Visual, Disruptive mechanism, PIV method.

INTRODUCTION

One of the important factors in the design of structures such as buildings, followed by bridge & dam is properly evaluated the role of stress-deformation behavior of soil under the Foundation. This factor depends on the mechanical characteristics of the soil. Karl von Terzaghi (1943) was the first theory to calculate the bearing capacity of the Foundation presented the final surface. The shear fissures Terzaghi beneath the surface of the end times is the same as Figure 1 tape a bedrock premise.

He has also replaced available soil at the top of the underlying bedrock surface with ($q = \gamma D_f$) overhead. (γ Is gravity Specific of soil)

The following soil to bedrock fissures in the area three separable area:

1. triangular area immediately below the Foundation (wedge disruptive).

2. Radial shear regions of the ADF and the CDE with curved fissures DF and DE.

3. Two Rankin-triangular area AFH and CEG.

In the case of reinforced soil disruptive mechanism, Huang and Menq (1997) proposed a theory based on the mechanism of failure of Wide-slab in the territory as shown in Figure 2. According to this theory the next disruptive of wedge and armed with a width ($B + \Delta B$) and the level-up areas of the Earth's surface ruptures finds development. The method presented is based on analytical studies and is now also laboratory is based on modeling. Most physical models based on data findings do force-is based on the following shift and usually the view is disruptive mechanism problem. Due to the complexity of the behavior of the soil that leads to the complexity of the interaction of soil and will be armed, a review of the behavior of reinforced soil deformation under the successive experimental tape cut makes it possible to understand the true mechanism of deformation or be disruptive.

This research enables us to examine the behavior of reinforced soil under different parameters and how to influence this parameter on slip surfaces created times compare over share.

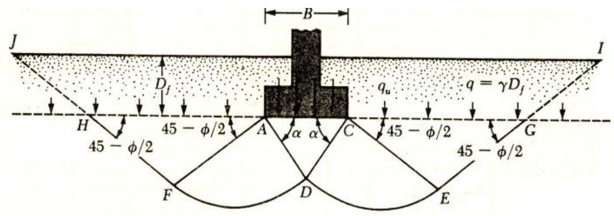


Figure 1. The ultimate in bearing shear fissures a rigid rough contact surface with tape infrastructure

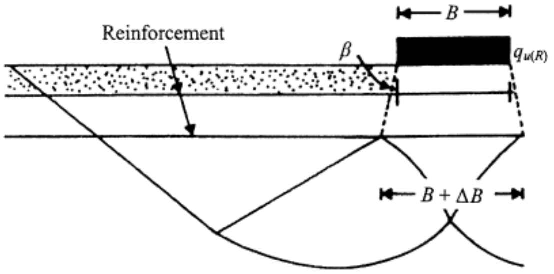


Figure 2. Failure mechanism the Wide-slab of reinforced soil under the foundation strip.

MATERIAL AND METHODS

Characteristics of the physical model

On the research of the soil dry sand was used as a test case. To determine the profile of gravel, particle experiments in accordance with the standard ASTM D 422-87, Specific gravity in accordance ASTM D 854-87 Were done. The sand contains. 002% decline from the number 200 sieve, as Sandy has been classified a bad seed. Other soil parameters is given in table 1. In relation to how to sand r, to create uniform models for use with loose gravel, sand and rain from a height of about 25 cm was poured.

Figure 3A shows the model and test case parameters and shows the manner of reinforcing soil foundation. For entering load, one rigid frame was designed and installed in the laboratory. First, one reinforced concrete bond foundation with 1.8m length, 0.40m width and 0.50m height was made and at the two ends of this foundation. The column base plate besides the six built were placed to stablish the columns. In this way, beam and column nodes were designed. As you can see in the figure 3 for connecting columns two UNP160 hopper was used and for beam, two UNP200 hopper node. Has been used and then, beam and column we strengthen by the band. Figure (3B) shows the supported structure of forcing system. For building the laboratory vessel that soil should be put on it, the metal plates with 3.9mm thickness and dimension of (1.0*0.3*0.6) m was used. Because of the photography, this system was formed with the case that has 3cm transparent talc to take photo in successive loadings.

The tool for loading in system is force controlling that by increasing the weights until interruption time, the sample has been increased. Due to the decreasing of loading from forcing system, lever load practice was used that has 1.1m*0.03m arm and has 0.03m thickness which the 3kg weight was installed at one side to make equilibrium of the system. The space between weights to loading place is 0.75cm; therefore, the amount of loads 9.3 times increases in every loading. Figure 4 shows the schematic picture of loading system and types of supports.

To transfer the entering force to tested soil, one rigid plate with the size of 0.3m*0.061m was used that work as a surface band foundation on soil bed. One digital load cell with 250kg capacity was used to measure the entering loads. In this case study, load cell was fastened by the bolt in the metal plate center that formed solid system. This solid system was placed exactly under vessel and under forcing system. For measuring the foundation settlement one displacement sensor (LVDT) was used that placed on and center of metal plate. The present research includes four loading tests.

To reinforce soil foundation two reinforced geogride and geotextile were used. The various tests parameters include: reinforced types (geogride and geotextile), reinforcement layer (N), depth of first layer (U), reinforcement wide (b) and space between reinforcement layers (h). Table 2 shows the features of testing models.

Table 1. Specifications of used sand

ϕ	G_s	$\gamma(gr/cm^3)$	C_u	C_c
27	2.67	1.5	1.25	0.992

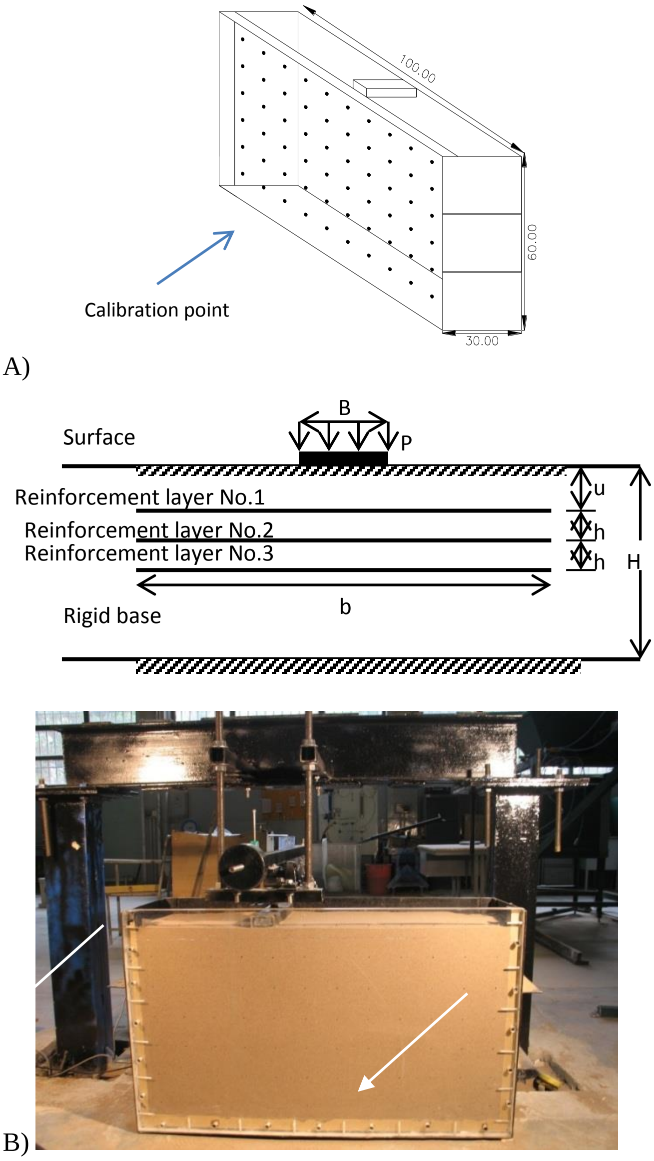


Figure 3. A) the model and test case parameters; B) the supported structure of forcing system and laboratory vessel

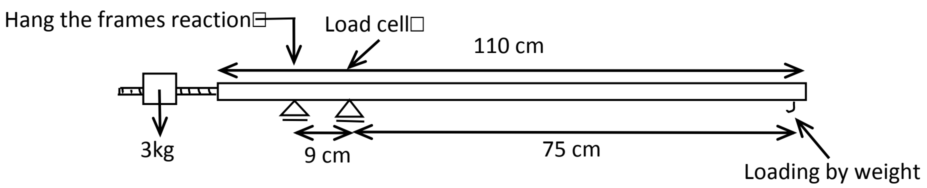


Figure 4. The schematic picture of loading system and types of supports

Table 2. The features of testing models

Test number	1	2	3	4
Reinforcement	Geotextile	Geotextile	Geotextile	Unreinforced
N	2	1	1	-
b/B	11	8	11	-
u/B	0.5	0.5	0.5	-
h/B	0.5	-	-	-
Calibration factor	0.093	0.277	0.088	0.217

Image processing (picture processing)

During the test by using PIV pictorial method that was utilized in fluid mechanic by Adrian (1991) in experimental studies for first time and recently was used by White et al. (2001-2003) for geotechnical modeling and for studying soil changings, the photos were taken of soil mass that had been changing with the digital camera with 7.1 mega pixel (3072*2304) clearness and these images were stored in computer memory and after tests, they were processed pictorial with the Geopiv8 software. These images divides to different tracks to process by the PIV methods and each track has special image tissue and this fact causes to determine the exact place of other images and it shows the tracks displacements (White et al., 2004).

The results of place changings of tracks in different pictures are in pixel unit and for changing to millimeter calibration factors are needed. These factors are placed in definite spaces with black color on the window (millimeter). The place of each calibration factor was determined by the close ranged photogrammetry and with regard to fixed spaces and fixed calibration factors during tests it can be transferred the tracks coordinates to the real places by using that calibration factors. The displacement vectors charge from picture to real spaces by close ranged photogrammetry and the soil plate displacement square will be obtained. In this research, by meshing the obtained pictures to the tracks (48*48), the suitable tissue for analysis was developed and the tracks displacement in soil masses in changing ways were obtained.

For example figure 5A shows the foundation settlements and curved shear displacement vectors on weak sands with the 10mm (s/b=0.18) (s stands for the settlement) settlement and it shows that in test1 reinforcement lays are place in Z/B=0.5. Displacements vectors inclined to downward the foundation because the soil is weak and it indicate the soil density under foundation.

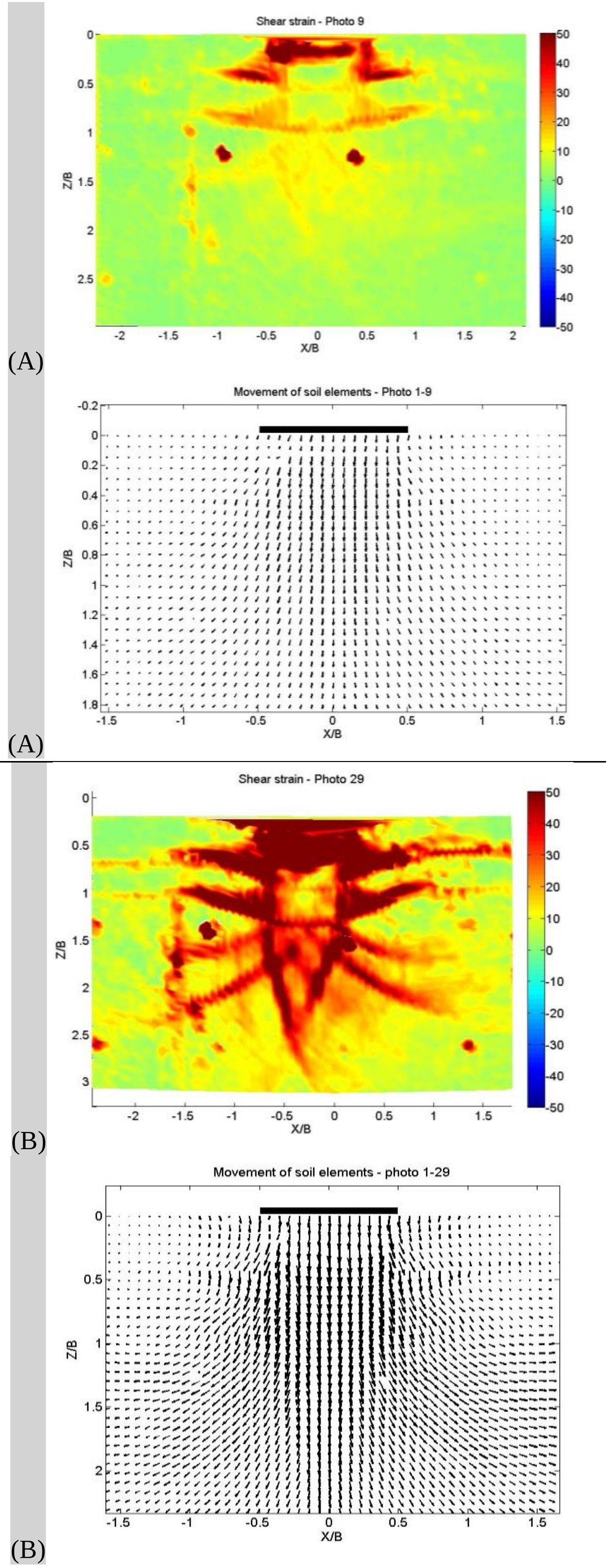


Figure 5: The foundation settlements and curved shear displacement vectors. (A): S/B=0.18, (B) :S/B=0.5

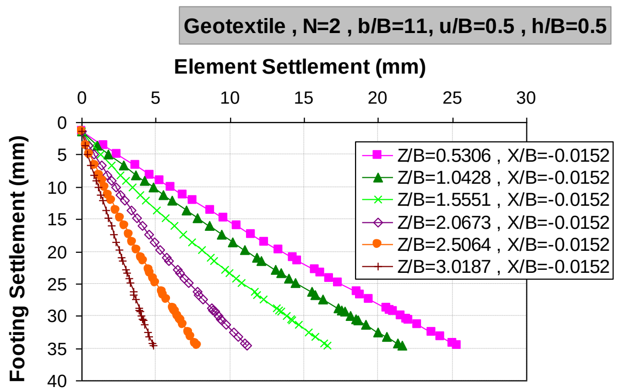
In left hand of figure 5A, aggregate curvature was developed and extends to Z/B=1 depth. This curvature was observed in width under reinforcement layers with the -1<(X/B) <1. Also, figure 5B shows the displacements vectors shear curvatures of the band foundation settlements that are the size of 30min(s/b=.5).

It can be seen that with settlement increasing disconnected wedges are formed under reinforcement layers while in low settlements there are no disconnected wedges and there are no radius and firm shearing in this aggregate curved settlement was developed until the depth of z/b=2.5.

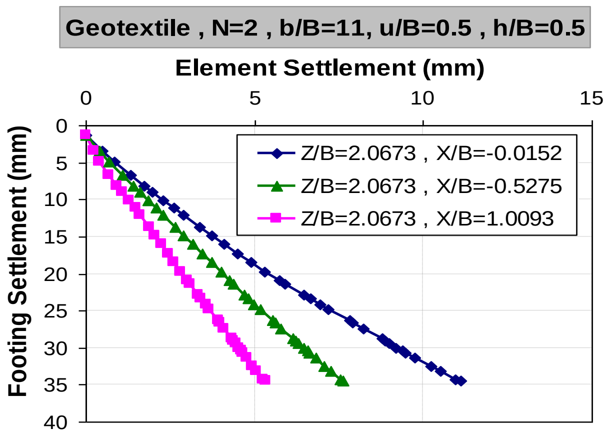
Also shear curved density that refers to existence of slip surface was seen under reinforcement layers.

RESULTS

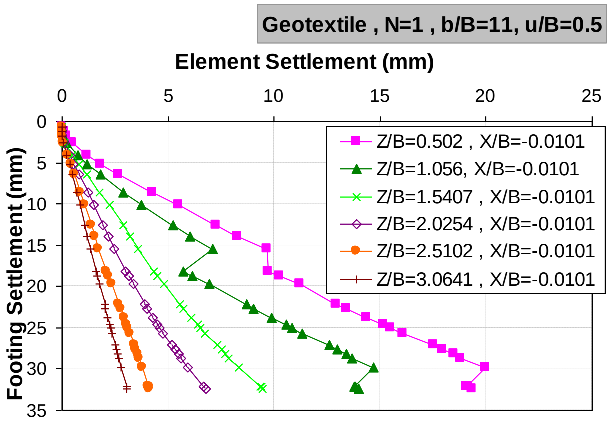
In all settlement tests, LVDT was used for measurement s and PIV analysis was used for determining the vertical and horizontal different parts of the soil. Figure (6A) shows the amount of horizontal trans for motions versus the amount of vertical transformations that were developed in various places of foundation that was observed in test1 with the reinforced geotextile layer (X is the space of function and Z is the depth).



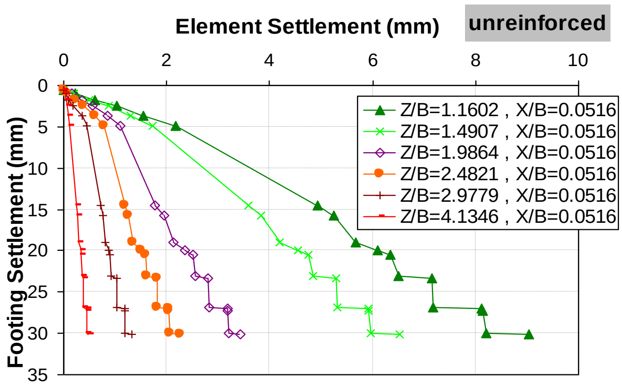
(A)



(B)



(C)



(D)

Figure 6. The soil elements settlement versus foundation settlement

As it can be seen, on the identical foundation settlement were decreased and in low depth the soil elements settlement was very lower than the foundation settlement, because the sand soil is very weak and it inclined to the density under foundation in increasing loads.

Figure (6B) shows the soil elements settlement versus foundation settlement that is for test1 and it is Z/B=2.0673 and X/B =0, 0.5 and 1. It was observed that in identical depth, by increasing the space of foundation center the soil element settlement was decreased relatively to the foundation settlement.

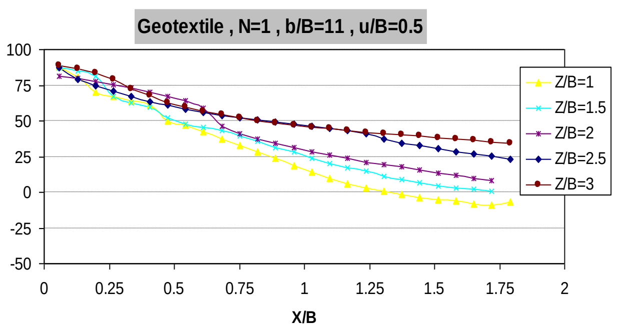
Figure (6C) shows the graphs of soil elements settlement with reinforcement layer (test3). It was observed that with identical foundation settlement with depth increasing, the soil element settlement was decreased and the amount of settlement relative to reinforced manner with two layers was small. Also, in unreinforced manner in figure (6D), the amount of settlement was too small. In reinforced manner with two layers the extensive range of soil was transformed because the reinforced layers were increased and it affect the lower depth of soil elements but in reinforced manner with one layer and it unreinforced manner, the surface shearing is smaller than the reinforced manner with two layers; therefore, the lower elements are affected by this displacement.

For transformation studies and soil element displacement under and around the foundation, the placement vectors angles were used. With regard to the vectors angles of elements under different depth of foundation and toward the horizontal on the figure7, it can be seen that how the displacement of band foundation was very different in reinforced soil with one geotextile layer and two geotextile layers with unreinforced manner which in one layer of reinforced (figure 7A), displacement vectors on the depth of Z/B=1 , X/B=1.25 were transformed on upper orientation and in Z/B=1.5, displacement vectors transformed to horizontal manner and in lower depth they close to each other in vertical manner.

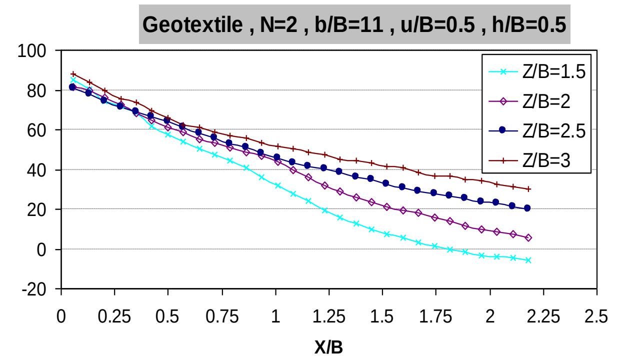
This situation was different for two layer reinforced soil (figure 7B) which in approximate depth of Z/B=1 and X/B=1.8 displacement oriented to upper level and gradually with increasing depth on Z/B=2 they close to horizontal manner. In unreinforced manner on Z/B= 1 and X/B=1.3 the soil elements move to upper level and gradually close to horizontal manner with increasing of Z/B and in figure (7C) it can be seen that in all three cases with increasing the depth of placement angles, they close to the horizontal manner.

Figure 8 shows the formed wedge in reinforced soil with one geotextile layer and also it shows the disconnected surface. The dark line of reinforced shows the geotextile layers before transformation. It is observed that the displacement vectors side under the reinforced layer is downward. The vectors sizes are larger in this parts that cause the reinforced layers to be transformed under the foundation. In radius shear regions and in strengthened regions it moves to upper level. On upper levels of reinforced layer, the displacement vector angles are not corresponding with below layers. On the geotextile layer, the disconnected situational surface was developed which are shown with blue colored lines. Gradually with increasing the depth of moving vectors to downward, the sizes of them are decreased.

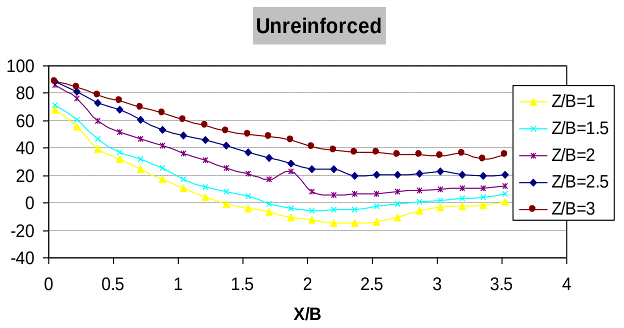
Also, in supported cases, the disconnected surfaces reached on the below reinforcement layer but it does not transfer to the earth. With regard to this graph it is known that the Huang and Menq theory is not correct.



(A) test 3



(B) test 1



(C) test 4

Figure 7. The vectors angles of elements toward the horizontal

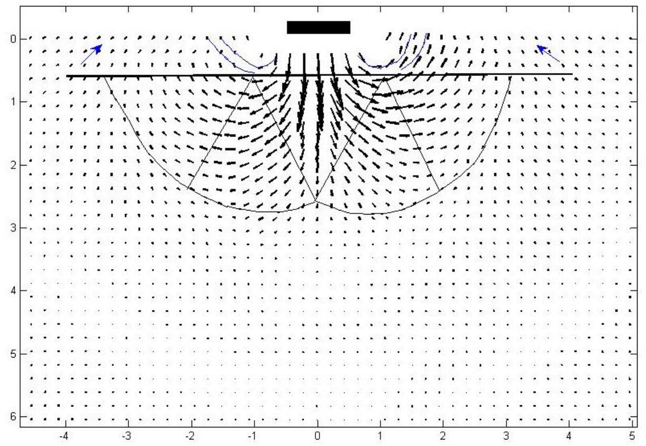


Figure 8. The formed wedge in reinforced soil (2)

CONCLUSION

By using PIV method, the disconnected surface was depicted for different tests. On the basis of observed results the displacements victors and reinforced foundation disconnected mechanism were considered and the obtained results are follows:

1. In this research it is shown that the formed disconnected wedge under the foundation are not correspond to the Huang and Menq theory.

2. It is obvious that the reinforcement effects depend on the number of layers and the condition of the tests. In useful application, two reinforcement layers are suitable because the loading capacity increases with regard to the number of layers.

3. The soil elements settlement in proportion to foundation settlement is loss because weak soil inclined to be dense. Also the placement angles of displacement vectors increase with the increasing of depth and it close to vertical manner. On top of the geotextile layer which the vectors orientation has been changed, the angles are negative. in reinforced manner with two layers, displacement vectors in depth of Z/B=1 and X/B=1.25 transformed to upper level but in reinforced manner with two layers in depth of Z/B=1.5 and X/B=1.8 the displacement oriented to upper level that shows the extensive disconnected surface in both horizontal and vertical sides of two layer reinforcements.

DECLARATIONS

Authors' Contributions

All authors contributed equally to this work.

Competing interests

The authors declare that they have no competing interests.

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