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POSITION OF STEEL TIEBACKS IN THE FUNCTION OF CONCRETE RETAINING WALL STABILITY

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ABSTRACT
The study analyzes the possibility of applying a concrete retaining wall with steel tiebacks as a function of different anchor position from the top of the retaining wall. For the same soil parameters as for the same cross-section of a concrete retaining wall, the stability of the external wall has been analyzed. On this basis, we can analyze the position of the steel tiebacks in terms of the obtained safety factor values. Also, it is possible to determine the optimal position of steel tieback and its position from the top of the concrete retaining wall.
Keywords: retaining wall, steel tiebacks, geostatic calculation

1. INTRODUCTORY DISCUSSION
Retaining concrete walls with steel tiebacks belong to earthwork filling supporting structure. By placing the steel tieback we get much smaller cross-section of the retaining wall. The force in the tieback gives the so-called stabilizing moment that opposes to the so-called destabilizing moment formed by the impact pressure of the soil and possibly groundwater level behind retaining wall. Concrete retaining walls with steel tiebacks are applied for construction of high walls, so that the force in tieback enables the less weight of the wall, which leads to less consumption of concrete in the construction of such walls. [1]

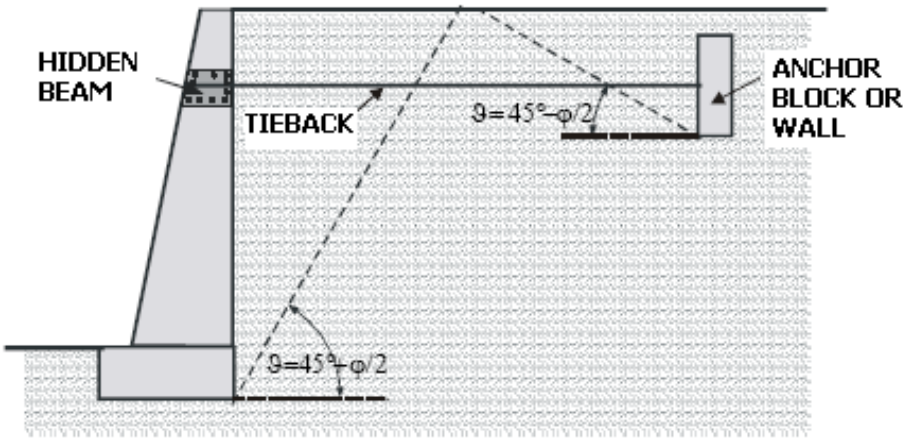

Figure 1. Cross-section of a concrete retaining wall with steel tieback

Steel tieback is placed in a reinforced concrete beam or reinforced concrete ring beam (hidden beam) in the retaining wall, while on the other end it is anchored in a special concrete block or wall. The height of concrete anchor block must provide necessary and sufficient resistance to tieback force. Usually the tiebacks are placed at the distance between up to 4.0 m along the concrete retaining wall. Since the tiebacks are made of steel, the insulation with bitumen or with other appropriate insulating material is required, and it ensures their durability. [2]

The purpose of the steel tieback, and the anchoring concrete block, is to activate the passive resistance of the soil which acts to the anchor block during the tieback displacement. This displacement can be controlled by pre-stressing the tieback and activating a part of passive resistance before the wall take the full load, so that after achieving the full force in tieback, displacement is less which together with the tieback elongation, allows the wall enough displacement to activate the minimum full active pressure. [1] [3]

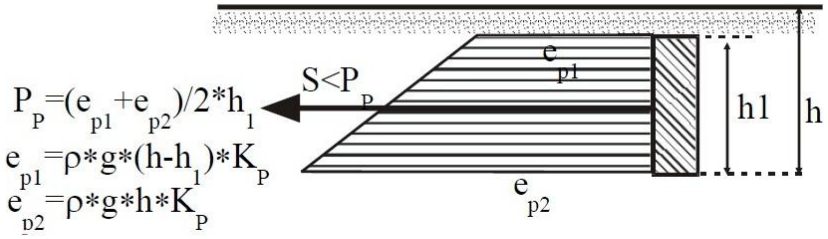

Figure 2. Diagram of passive soil (ground) pressure on the concrete anchor block or wall

Special attention should be paid to the tieback anchoring spot/position. In case of the anchor wall, it needs to be dimensioned as a bracket whose anchoring spots are bracings. [4]

2. CHARACTERISTICS OF THE MODEL

For the analysis of the stability of the concrete retaining wall with steel tieback, the model with the same cross section of the wall and the same parameters of soil behind the wall was analyzed. In all analyzed cases, there was no influence of external load behind the wall. Also, in all the analyzed cases there was no influence of the ground water level behind the wall.

The height of concrete retaining wall with tieback is 600 cm with a foundation width of 300 cm in all analyzed cases. The thickness of retaining wall is 40 cm at the top and the wall thickness at the junction with the foundation is 80 cm. The thickness of the foundation of the retaining wall is 80 cm. The analyzed model only has a front foundation overhang of 220 cm while there is no rear foundation overhang.

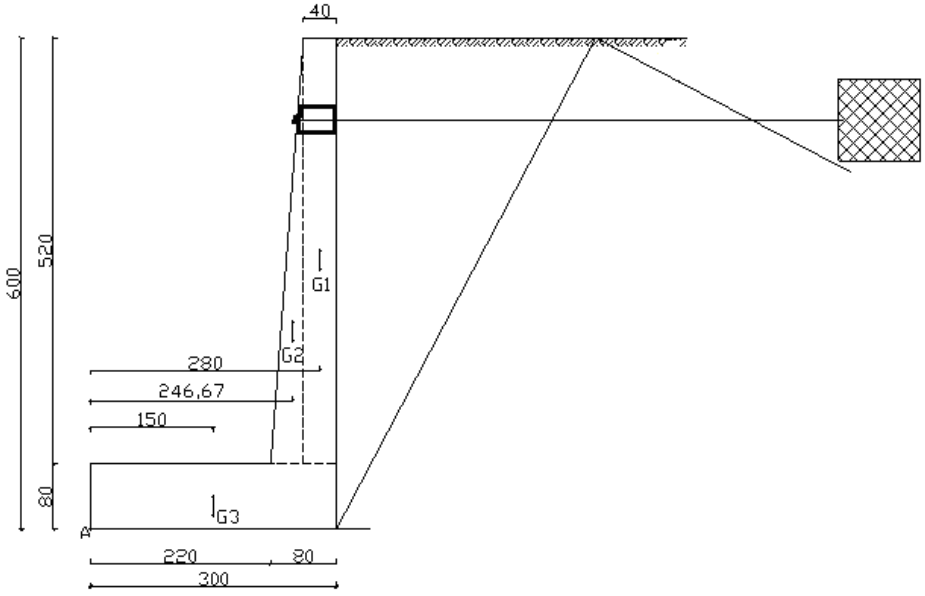

Figure 3. Analyzed cross-section of the concrete retaining wall

Behind the retaining wall there is soil with the same characteristics: γ=19,0 kN/m^3, φ=35^o and c=0 kN/m^2. In the analyzed model the only changes are in the position of the steel tieback from top of the wall at a depth of 100 cm, 150 cm, 200 cm and 250 cm. In this way the external stability of the

retaining wall was analyzed, and it is possible to determine the optimal range of the position of the tieback for the given conditions.

3. THE RESULTS OF ANALYSIS

The adopted model analyzed five different cases. In the first case we analyzed retaining concrete wall without tieback with previously mentioned characteristics, while in other cases the tieback is at a depth of 100 cm, 150 cm, 200 cm and 250 cm from the top of the retaining wall. Through conducted geostatic calculation we obtained the safety factors on sliding and overturning for all these cases and positions of the steel tieback. The weight of a concrete retaining wall, for the analyzed model is 132,48 kN/m'.

In the first case without the steel tieback, the conditions and requirements of the external stability on sliding and overturning were not met.

By installation of steel tieback we obtain satisfactory safety factors on sliding and overturning for all positions of the tieback from top of the retaining wall. This means that by increasing the depth of the steel tieback from top of the wall, the intensity of the tieback force increases as well.

SAFETY FACTOR	**REINFORCED CONCRETE RETAINING WALL**				
	Without tieback	Tieback at a depth of H=100cm	Tieback at a depth of H=150cm	Tieback at a depth of H=200cm	Tieback at a depth of H=250cm
Safety factor on sliding F_{SK}	1,00	1,62	2,33	4,19	35,01
Safety factor on overturning F_{SP}	1,48	5,35	6,68	7,63	8,20

Figure 4. Results of conducted analysis

In case when the steel tieback is at a depth of H = 250 cm from the top of the retaining wall, the safety factor on sliding is significantly higher than the safety factor on overturning. This is the result of approximation of the force action spot in the tieback and active soil/ground pressure.

4. CONCLUSIONS

By conducted geostatic analysis, it is concluded that the maximum depth to which the anchoring of steel tiebacks is rational, in this example, and in this model, is H=260cm from the top of the wall.

By anchoring tiebacks deeper than this, the tieback force would be greater than the force of active soil pressure, which is not a good technical solution. Also, the shifting of anchoring spot along the height of the wall increases the length of the tieback, and the anchor block must be anchored at a greater distance from the wall, which in some circumstances is not acceptable. Based on the above, it is concluded that the tieback should be anchored at the upper third of the height of the concrete retaining wall. Tieback anchored in this area gives the best results of safety factors on sliding and safety factors on overturning.

5. REFERENCES

[1] Suljić N.: Supporting constructions, university textbook, University of Tuzla, 2010.
[2] Maksimović M.: Mechanics of soil, AGM Book Belgrade, 2008.
[3] Suljić N.: Modern materials for the construction of retaining structures, IGK Planjax Tešanj, 2005.
[4] Stević M.: Mechanics of soil and rocks, University of Tuzla, 1991.