UDC: 624.131.04:725.893(497.751)
Professional paper

THE SCOPE OF THE CONDUCTED FIELD INVESTIGATIONS SUFFICIENTLY DEFINES THE SOIL ENVIRONMENT WHERE THE RENOVA STADIUM FOUNDATION AND TRIBUNES WILL TAKE PLACE

Idaver Huseini[1], Nexhmi Krasniqi[2], Asan Idrizi[1]

[1*] *Faculty of Civil Engineering-University of Tetova, Republic of North Macedonia*
[2]*Faculty of Civil Engineering-University UBT of Pristina, Republic of Kosovo*

Abstract

The task is to show the calculations of statics and dimensioning strip foundations and foundation slab of the building. We also analyzed the impact of the various modules of subgrade reaction on the base plate and strip foundations of the stadium tribunes.

The methodology of the research work and laboratory tests is in accordance with the technical regulations, current standards, as well as the guidelines and recommendations from the literature that are common in practice in the country and abroad for these types of stadiums.

According to the soil failure criterion, the soil load bearing capacity is determined according to the Tercaghi formulation:

- Rectangular single spread footing: $qf = 1.4cNc + \gamma_1 DfNq + 0.5\gamma_2 BN\gamma$
- Rectangular wall footing: $qf = cNc + \gamma_1 DfNq + 0.5\gamma_2 BN\gamma$
- Slab foundation: $qf = (1+0.4n)cNc + \gamma_1 DfNq + 0.4\gamma_2 BN\gamma$

For the purposes of structural analysis, in addition to the allowable load bearing capacity of the foundation, the modulus of the soil reaction was calculated according to the method of Bowles, $Ks = Fs \times 40 \times \sigma_{all}$ (kN/m^3).

Keywords: physical - chemical characteristics, geomechanical characteristics, KS., φ, c, γ1.

1 Introduction

In the location in KP.1932, KO. Neproshteno, near the regional road Tetovo- Jažince, is planned to build the facility, a Football Stadium, with minimum field dimensions of 80.0 x 120.0 m ’and stands.

To determine the essential physical-mechanical and deformable characteristics of the soil where the footing of the building will lay, all the necessary engineering, geological, and geo-mechanical field research works, and laboratory examinations were properly undertaken.

The methodology of the research work and laboratory tests is in accordance with the technical regulations, and current standards, as well as the guidelines and recommendations from the literature that are common in practice in the country and abroad for this type of building.

The undertaken geotechnical investigations were intended to determine the lithological composition of the soil layers in depth, i.e. to determine the field conditions for the construction of the building, to determine the groundwater level (if there is any), to determine the deformable characteristics of the soil where the building will be footed, as well as to understand other relevant data needed for the most optimal funding along with the functionality and stability of the facility during construction and operation.

The results of the field research work, and laboratory tests are presented through appropriate graphic attachments, spreadsheets, and diagrams, whereas their interpretation is given in the textual part.

2 Field investigation

The field investigation includes the following activities:

- Engineering-geological and hydrogeological mapping of the terrain where the considered building is located;
- Drilling machines with research holes
- Geotechnical mapping of the material from the wells;
- Taking disturbed samples for laboratory examination.

Samples from the exploration wells are taken regularly according to the applicable standards and are submitted to the laboratory for further testing.

Table 1. Properties of samples taken from the exploration wells

Number of well	Depth (м’)	Groundwater level/appearance (м’)	Note
B-1	8.0	/	June ‘20
B-2	8.0	/	June ‘20
B-3	8.0	/	June ‘20
B-4	8.0	/	June ‘20
B-5	8.0	/	June ‘20

Table 2. Seismicity coefficient

Intensity according to MKZ	Кs
VII	0.025
VIII	0.050
IX	0.100

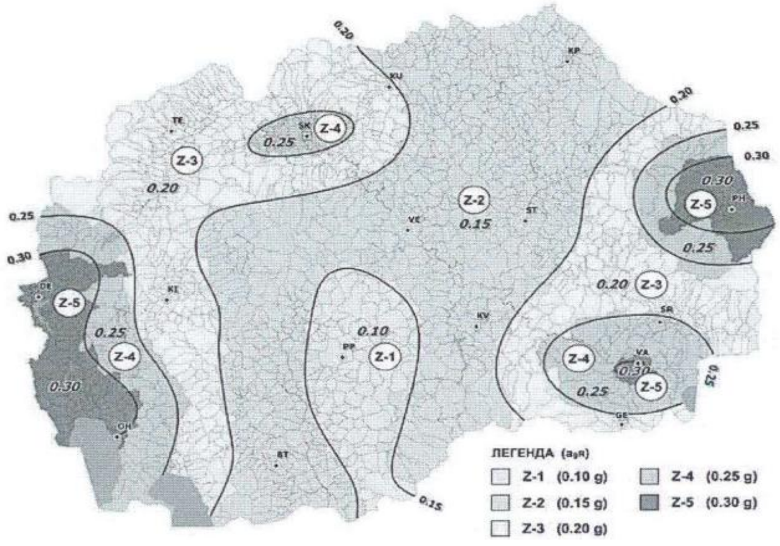


Figure 1. Seismic map of RNM for a return period of 500 years

3 Methods

3.1 *Soil failure criterion*

According to the soil failure criterion, the soil load bearing capacity is determined according to the Tercaghi formulation:

- Rectangular single spread footing: $qf = 1.3cNc + \gamma_1 DfNq + 0.4\gamma_2 BN\gamma$ (1)
- Rectangular wall footing: $qf = cNc + \gamma_1 DfNq + 0.5\gamma_2 BN\gamma$ (2)
- Slab foundation: $qf = (1+0.3n)cNc + \gamma_1 DfNq + 0.5\gamma_2 BN\gamma$ (3)

Where: qf – load bearing capacity (kPa); c – cohesion (kPa); γ_1, γ_2 – volume weight above and below the foundation level (kN/m^3); Df – effective foundation depth (m); B – footing width (m); Nc, Nq, Nγ - load factors depending on the angle of internal friction (φ).

For the purposes of structural analysis, in addition to the allowable load bearing capacity of the foundation, the modulus of the soil reaction was calculated according to the method of Bowles, Ks = Fs x 40 x σ_{all} (kN/m^3).

3.2 *Tercaghi formulation*

When determining the allowable load bearing capacity, an internal friction angle of φ - 18.4° is adopted.

The calculation of the allowable load is given in the following table 3 for single foundations.

$$qf = 1.3cNc + \gamma 1DfNg + 0.4\gamma 2BN\gamma \quad (4)$$

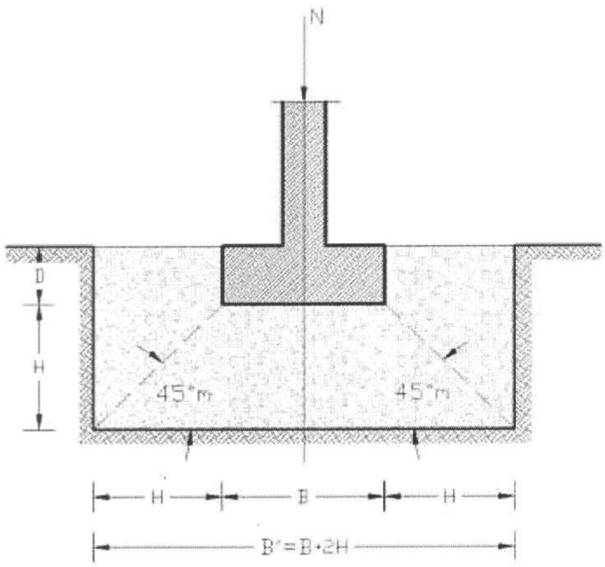


Figure 2. Width of the replaced buffer layer

The calculation of the **allowable load** is given in table 6 for slab foundation.

$$qf = \mathbf{1.3}cNc + \gamma_1 DfNg + \mathbf{0.4}\gamma_2 BN\gamma$$

φ =	19,9	(°)
C =	21,7	(kPa)
γ_1 =	19,14	(kN/m^3)
γ_2 =	19,14	
Nc'=	12,34	
Nq' =	4,84	
Nγ' =	2,23	
Fs	3	

Tabela nr.6

Df	B	L	σdoz	Ks
(m)	(m)	(m)	(kN/m^2)	(kN/m3)
1,5	2,0	2,0	173,74	20848,5
1,5	2,5	2,5	176,58	21190,0
1,5	3,0	3,0	179,43	21531,5
1,5	3,5	3,5	182,27	21872,9
1,5	4,0	4,0	185,12	22214,4
1,5	4,5	4,5	187,97	22555,8
1,8	2,0	2,0	183,00	21960,2
1,8	2,5	2,5	185,85	22301,7
1,8	3,0	3,0	188,69	22643,1
1,8	3,5	3,5	191,54	22984,6
1,8	4,0	4,0	194,38	23326,0
1,8	4,5	4,5	197,23	23667,5
2,2	2,0	2,0	195,35	23442,4
2,2	2,5	2,5	198,20	23783,9
2,2	3,0	3,0	201,04	24125,3
2,2	3,5	3,5	203,89	24466,8
2,2	4,0	4,0	206,74	24808,2
2,2	4,5	4,5	209,58	25149,7
2,5	2,0	2,0	204,62	24554,0
2,5	2,5	2,5	207,46	24895,5
2,5	3,0	3,0	210,31	25237,0
2,5	3,5	3,5	213,15	25578,4
2,5	4,0	4,0	216,00	25919,9
2,5	4,5	4,5	218,84	26261,3

The calculation of the allowed load is given in table no. 7 for rectangular foundations (strip)

$$qf = cNc + \gamma_1 DfNq + 0.5\gamma_2 BN\gamma$$

φ =	19,9	(°)
C =	21,7	(kPa)
$\gamma_{1/2}$ =	19,14	(kN/m^3)
Nc' =	12,34	
Nq' =	4,84	
Nγ' =	2,23	
	Fs =	3,0

Tabela nr.7

Df (m)	B (m)		σdoz (kN/m^2)	Ks (kN/m3)
1,5	1,2		144,11	17293,7
1,8	1,2		153,38	18405,4
2,2	1,2		165,73	19887,6
2,5	1,2		174,99	20999,3
1,5	1,5		146,25	17549,8
1,8	1,5		155,51	18661,5
2,2	1,5		167,86	20143,7
2,5	1,5		177,13	21255,3
1,5	1,8		148,38	17805,9
1,8	1,8		157,65	18917,6
2,2	1,8		170,00	20400
2,5	1,8		179,26	21511,4
1,5	2,2		151,23	18147
1,8	2,2		160,49	19259,0
2,2	2,2		172,84	20741,2
2,5	2,2		182,11	21852,9
1,5	2,5		153,36	18403,5
1,8	2,5		162,63	19515,1
2,2	2,5		174,98	20997,3
2,5	2,5		184,24	22109,0

4 Deformation calculation (subsidence)

From the performed analysis for foundation strips on a bonified substrate with dimensions 1.0x2.0m and for a foundation slab on a non-bonified substrate, it is found that only small subsidence within the permissible limits is obtained.

However, due to the weak characteristics of the considered soil materials and the proposed soil replacement (bonification) at the foundation level, the consolidation (laying) of the foundation will be done almost instantly with the application of each load rate and they will end to a large extent in construction phase due to the favorable consolidation characteristics of the foundation.

Table 8. Deformation calculation

$\sigma_{zo.} = \sigma_{doz} - \gamma t =$ 203,89 - (19,14 x 4.0) = 127,3 kN/m²

Shtresë	γ (KN/m3)	z (m)	a=L/2 (m)	b=B/2 (m)	n = z/b	m = a/b	k	σ_{zi} (kN/m²)	P_γ (kN/m²)	H_i (m)	M_{si} (kN/m²)	ω_i (m)
1	2	2	3	4	5	6	7	8	9	10	11	12
		0,00						*127,3*	*76,6*			
1	19,14	*-0,40*	1,8	1,75	0,23	1,00	0,248	*126,3*	*84,2*	0,80	12000	*0,00842*
2	19,14	*-1,40*	1,8	1,75	0,80	1,00	0,200	*101,8*	*103,4*	1,20	12000	*0,01018*
3	19,14	*-2,25*	1,8	1,75	1,29	1,00	0,142	*72,4*	*119,6*	0,50	12000	*0,00302*
4	19,14	*-2,75*	1,8	1,75	1,57	1,00	0,115	*58,4*	*129,2*	0,50	12000	*0,00243*
5	19,14	*-3,25*	1,8	1,75	1,86	1,00	0,093	*47,4*	*138,8*	0,50	12000	*0,00197*
											$\Sigma\omega_i$	*0,02603*

Thellësia aktive e uljeve : σ_{zi} = max 20% P_γ

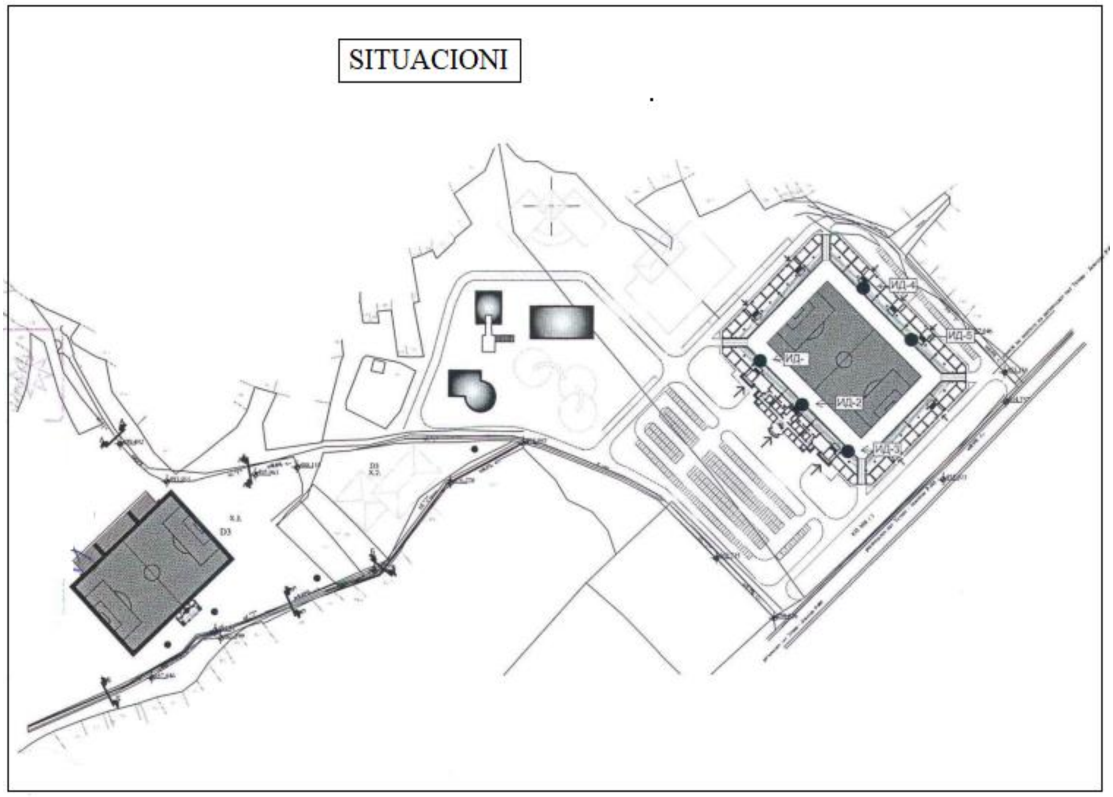
σ_{zi}/P_γ = 34,1%

$\rho = 3/4\Sigma\omega_i =$ ***0,020*** m

L= 3,50 (m)

B= 3,50 (m)

5 Graphical part



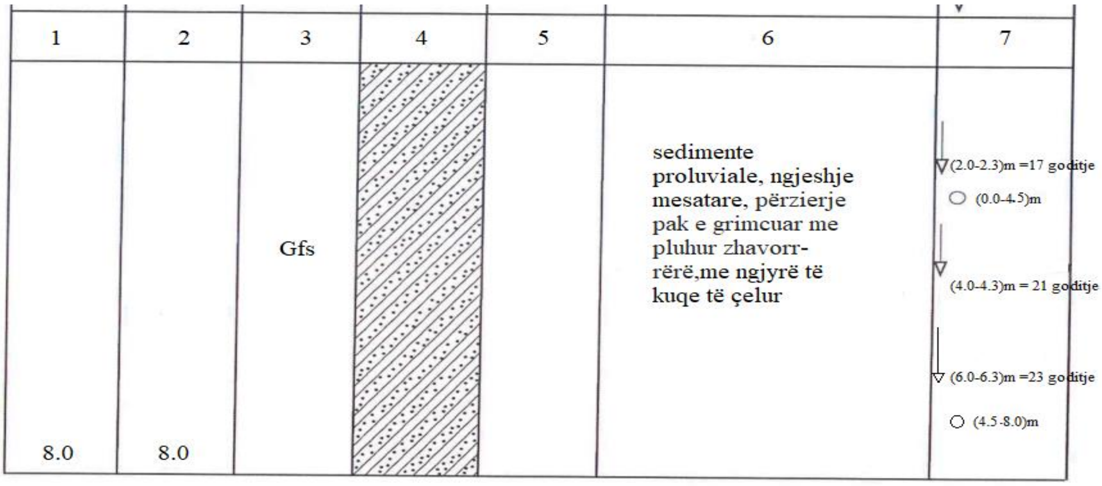


Figure 5.1. Lithological description

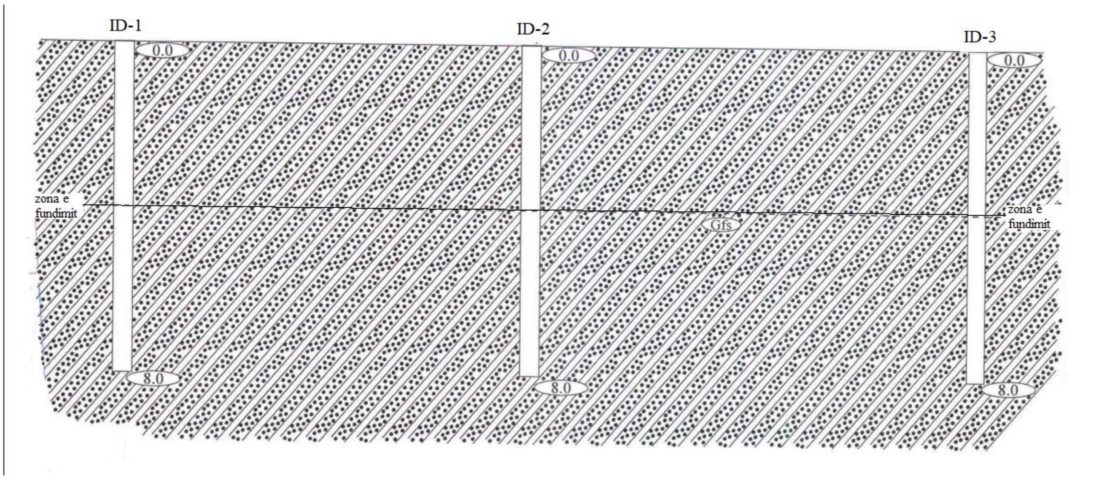


Figure 5.2. Geomechanical profile

Figure 5.3

Conclusions and recommendations

Based on the performed field and laboratory tests, the following recommendations and conclusions can be made:

From the observed geological point of view proluvial sediments in the Polog valley are present

- In geomechanical terms, the level of the foundation should be in the represented layer of: a medium compacted mixture, poorly granulated, with gravel-sand powder with geomechanical designation GFS with relatively good bearing characteristics.
- According to the basic seismotectonic characteristics of the surveyed area: local conditions for the land category of the terrain location belong to category II
- According to the categorization of buildings and depending on their importance in society and the number of users, this building belongs to category I of buildings.
- We suggest that the foundation of the building (tribunes) be made with separate foundations.
- Excavation will be carried out in categories II and III according to GN-200 standards.
- The designer can take other allowable load capacities - different from the recommended one, depending on the dimensions of the foundations and the effective depth of the foundation Df, but in accordance with the calculations for the allowable load capacity in tables no. 6 and 7 of this Report
- The calculations, conclusions, and recommendations from this study are valid only for the examined location. In case of some changes additional geotechnical tests, analysis, and calculations are required.

References

[1]. Ameti, F. (1986): “Mekanika e dherave”, Prishtinë, Kosova

[2]. Luljet B.(2002) Gjeoteknika 2 themele (pjesa e pare)

[3]. Craig, F. (1978):”Soil mechanics”, London, United Kingdom.

[4]. Geotehnical design, Part 1, G[12] Eurocode eneral rules.

[5]. Šuklje L. ‘Mehanika tla”, Lublana 1967

[6]. Nonweiller E. ”Geomehanika” I, II i III deo, Gradjevinski fakultet u Zagrebu 1971

[7]. Stojadinović. R. Inžinjerske osobine tla, IIdeo. Begrad 1973