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The Geotechnical Evaluation of the Proposed Teeb Dam Site at Missan Governorate

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Abstract

The standard Penetration Test (SPT) results are used to describe and evaluate the consistency of cohesive soils and the compactness of the non-cohesive soils of Teeb dam site. This hydraulic structure located on Teeb river at the north east of Missan governorate is proposed to collect and regulate flood water of winter season and groundwater recharge. The SPT results are also used to calculate the relative density and the angle of internal friction after correcting the N- values. Relative density values range between 38- 96 % and internal angle of friction range between 27.65- 45°. The bearing capacity of beds in the proposed Teeb dam site is classified according to SPT value to four main beds, very stiff silty clay, medium dense poorly graded sand , dense poorly graded gravel and very dense poorly graded gravel mixed with sand.

Key words: Standard Penetration Test, relative density, angle of internal friction.

Introduction

A dam is an obstruction that stops or confines the flow of water or underground flows [1]. Supplies made by dams smother surges as well as give water to exercises, for example, water system, human utilization, mechanical utilize and aquaculture. The breaching of a dam causes immeasurable damage, so it is important to think of how to protect dams and to keep them doing the purpose they have made for.

Geotechnical assessment of the dam's foundations is important to avoid many engineering problems and make correct descion sites, such as finding suitable materials, choose optimum designs, and searching for the causes of dam collapse. The engineering evaluations of the ground materials in the dam site area represent the main task for the engineering geologists in the site.

Teeb dam project is located in the Teeb area of Missan governorate. The area extends from the Hamreen mountains on the border to the south-west towards the Iraqi plains to form the course, rain and floods water coming from mountainous areas on the border, which represent the recharge basin of Teeb river: Collecting and regulating these water for summer season and

groundwater recharge will help bring life back to the region.

The N- values of standard penetration test (SPT) were used to describe and evaluate the consistency of cohesive soils and the compactness of the non-cohesive soils at the dam site. The study is based on the N-values mentioned in the report [2], SPT field values were corrected based on equation1[3]:

$N_{Corrected}$= 15+0.5($N_{measurement}$-15).....(1). This equation is used for N-value larger than 15.

Many mathematical relationships are used to calculate numbers of geotechnical properties of soil such as angle of internal friction and relative density. Angle of internal friction of soil in study area is estimates according to [4].Relative density is estimates according to [5]

$$Ø= (20N_{60})^{0.5} +15 \text{ ……..2}$$

Location of the Dam Site

The dam site is located at the south-east of Iraq, in the north-east of Missan. Teeb dam sites located on Teeb river in an area between latitudes 47° 6" 0 - 47° 18"0 east and latitude 32° 18" 0 - 32° 30"0 north as shown in Fig1.

Aims of the Study

1- Calculation of some geotechnical properties based on the values of the field standard and corrected penetration tests and grain size distribution.

2- Draw the geotechnical sequence of the bearing strata at the dam site.

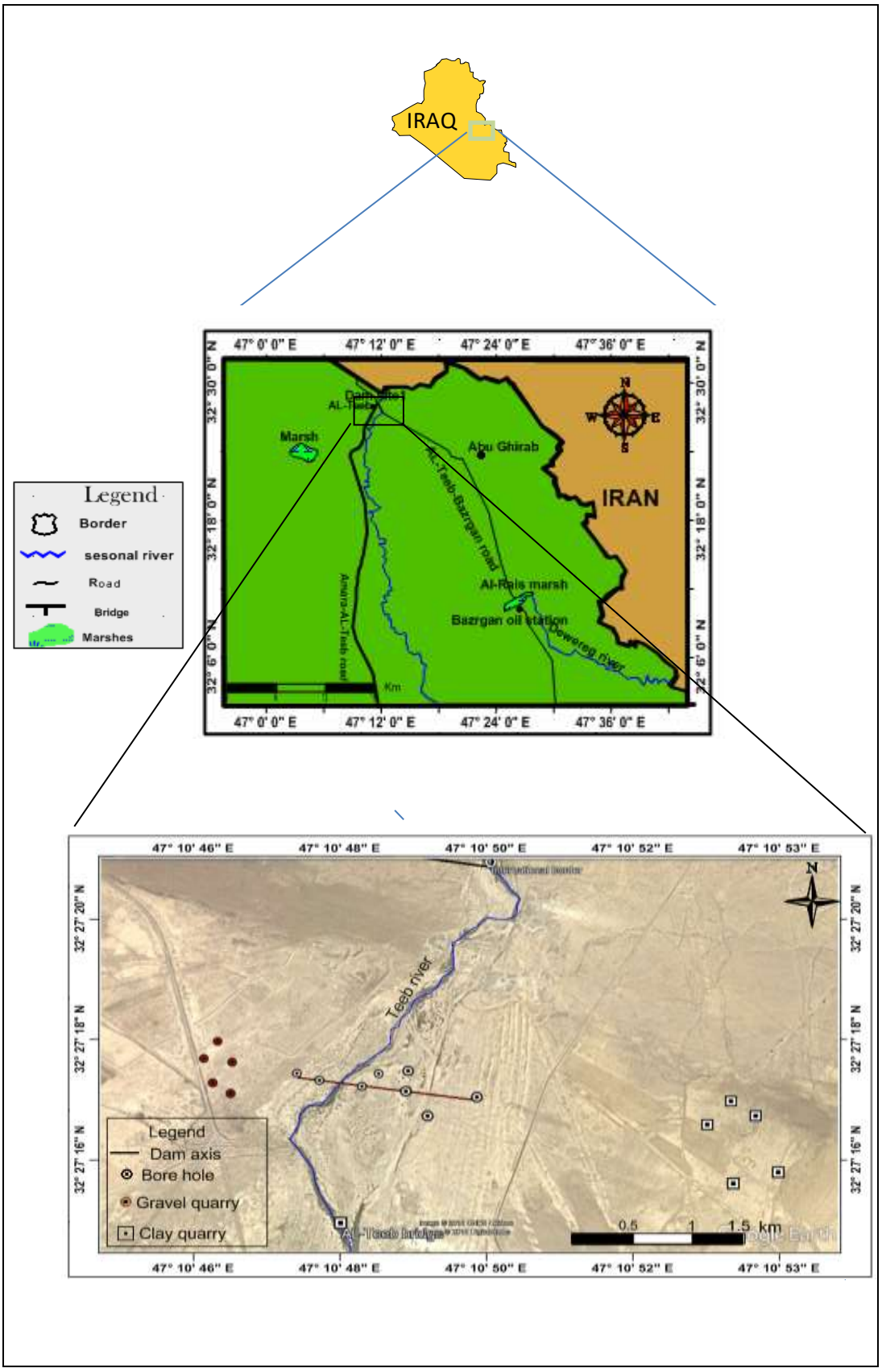

Fig. 1 Location of Teeb dam site.

Methodology

For the purpose of completing the research and obtaining the results that achieve the aims, the following steps should be performed.

1-Office Work: Reviewing literatures and previous geological, hydrological and geotechnical reports, and compute some of engineering properties using indirect methods .

2-Laboratory Work: Laboratory work including grain size distribution based on [6].

3-Program: The most important software which used in study

- Arc GIS 10.1 is used to draw the study area map.
- SURFFERV.13 is used to draw bore holes at study area.
- TCX is used to convert geographic coordinates to UTM .
- GRAPHER V.13 is used to draw figures of distribution of relative density and angle of internal friction with depths of bore holes.

Results and Discuss

SPT correction

The results of SPT were shown in the Figs 2 to 9. There is a difference between the SPT results from field and corrected values as shown in these figures. In dam site, the SPT values were used to describe the consistency of cohesive soil and the compactness of non-cohesive soils at the study area, according to[3] classification The N-values after correction indicated that the shallow layer appears at BH-1,BH-4 and BH-6 is medium dense silty sand (SM) at depth 0-1m. Very dense silty sand (SM), silty gravel (GM) and hard silty clay (CL) appear at the soil profile down to about 1-5m. Generally the soil shows cone blows mostly higher than 100 indicating strong layer down to the end of boring.. The increase in the values of SPT is due to the fact that sediments are exposed to normal consolidation or mechanical compaction due to increase of overburden pressure during sedimentation processes,which leads to increase shear resistance and decrease compressibility[7]

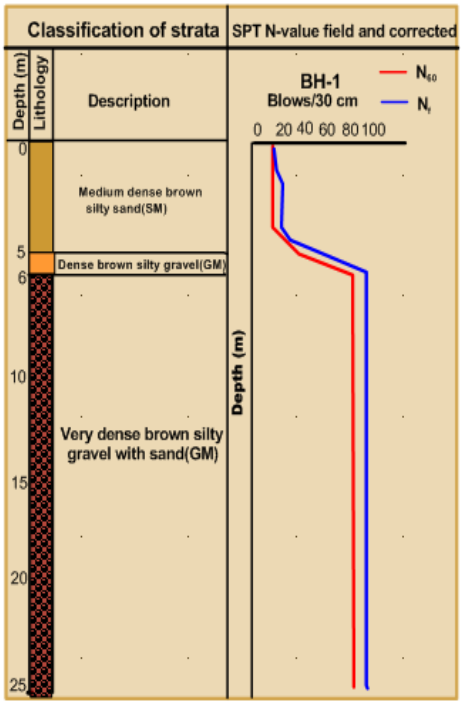

Fig2 N-Value at Proposed Dam Site,BH-1

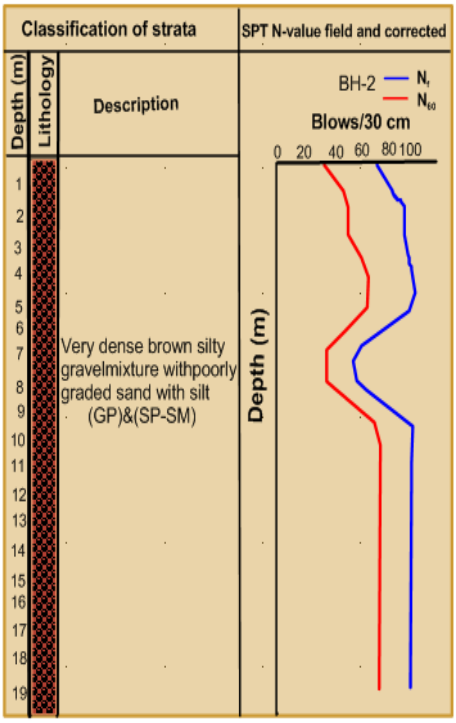

Fig3 N-Value at Proposed Dam Site,BH-2

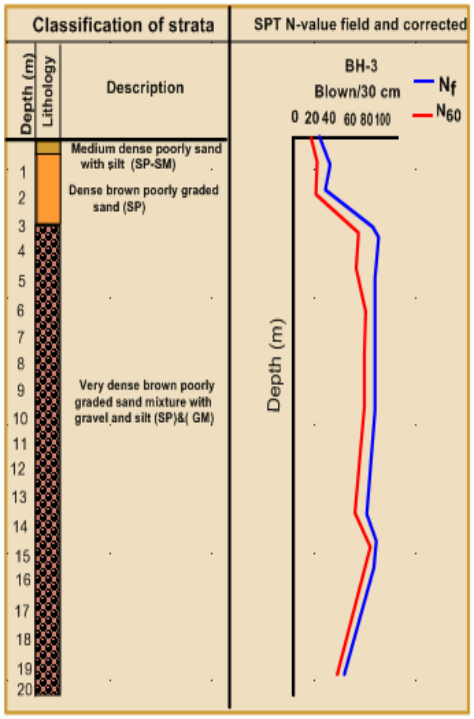

Fig 4 N-Value at Proposed Dam Site,BH-3

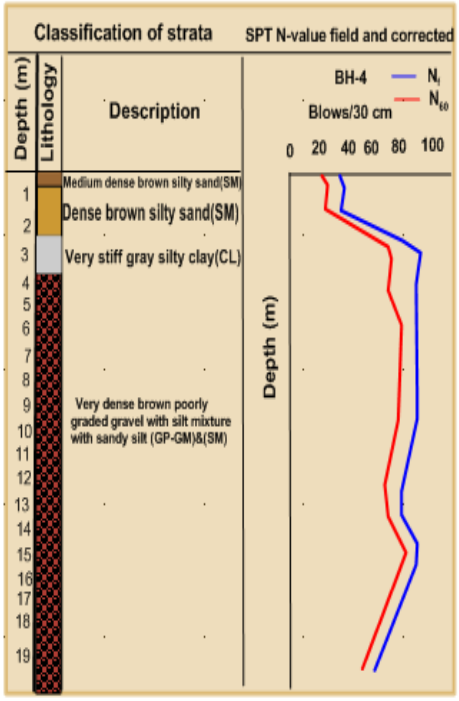

Fig 5 N-Value at Proposed Dam Site,BH-4

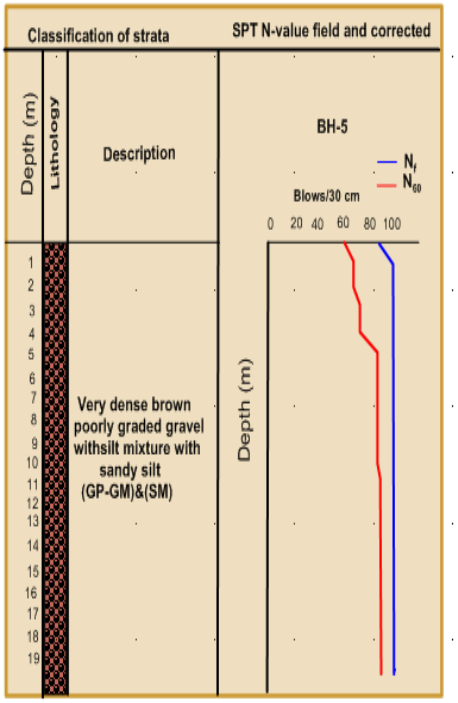

Fig 6 N-Value at Proposed Dam Site, B

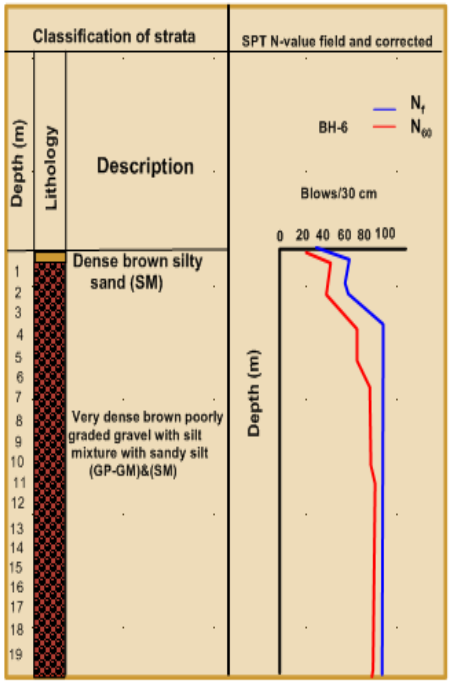

Fig 7 N-Value at Proposed Dam Site, BH-6

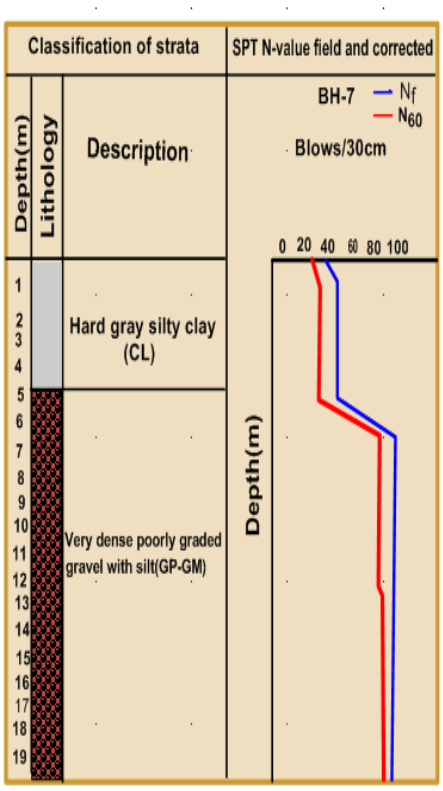

Fig 8 N-Value at Proposed Dam Site,BH-7

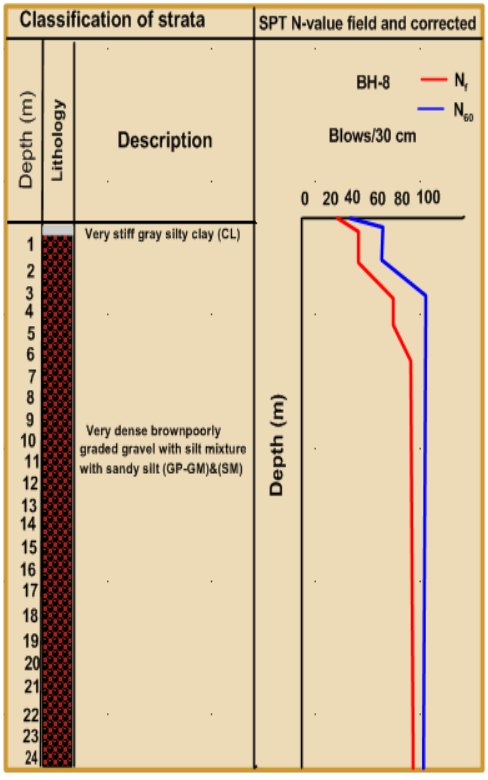

Fig 9 N-Value at Proposed Dam Site,BH-8

Cross Section of the Geotechnical Sequence at the Dam Axis Site after Correction of SPT values

Analysis of the results of the site investigation and laboratory tests at the dam site classified soils to beds as shown in Fig 10, and Table 1:

1- Medium dense silty sand (SM). It appears at BH-1 with thickness 5m Fig 2, BH-3 with thickness 0.5 m as shown in Fig.4.

2- Dense silty gravel with sand (GM) and dense poorly graded sand (SP). These layers appear at BH-1with thickness1m at depth 5-6m, BH-3 with thickness 2.5 m at depth 0.5-3m and BH-4 with thickness 1.5 m.at depth 0.5-2m, as shown in Figs. 2, 4 and 5.

3- Very stiff silty clay (CL). It appears at BH-4 with thickness 2 m at depth 2-4m, 5 m at BH-7 at depth 1-5m and 1m at BH-8 at depth 1m Table 1 and Fig 5, 6, 7 and 8.

4- Very Dense silty sand(SM) and very dense silty gravel with sand (GM).It appears at BH-1 with thickness 19m at depth 6-25m, BH-3 with thickness 17 m at depth 3-20m, BH-4 with thickness 16m at depth 4-20m, BH-6 with thickness 19.5m at depth 0.5-20m, BH-7 with thickness 15m at depth 5-20m and BH-8 with thickness24.5 at depth 0.5-25 m as shown in Fig.5.

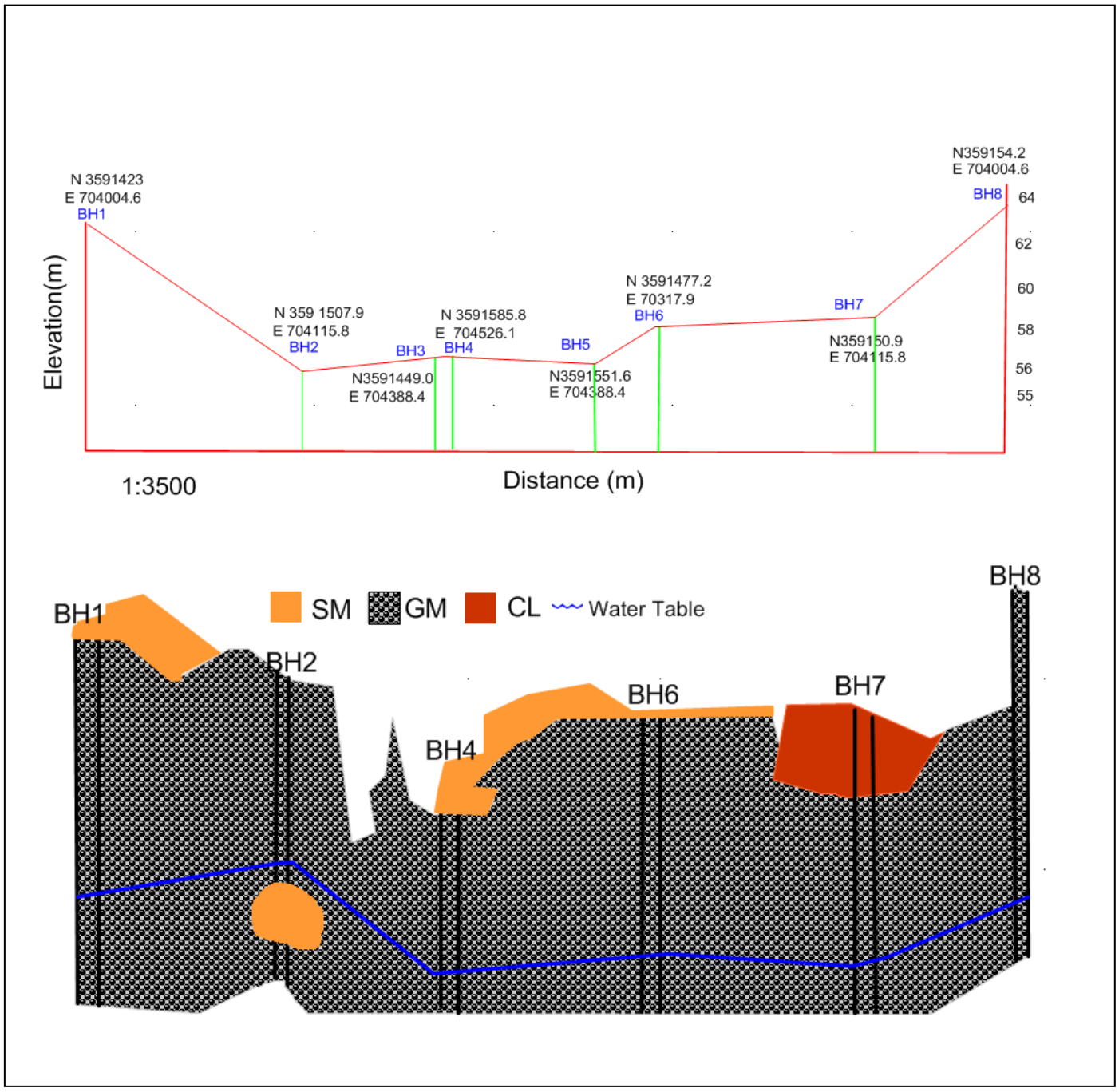

Fig. 10 Cross Section of the Geotechnical Sequence at the Dam Site Axis

Table 1: Grain Size Distribution of Teeb Dam

BH.No.	Depth(m)		Grain Size Distribution %			USCS	BH .No.	Depth(m)		Grain Size Distribution %			USGS
	From	To	Clay+ Silt	Sand	Gravel			From	To	Clay+ Silt	Sand	Gravel	
BH1	0	1	0	53	47.4	SP	BH5	9.5	10	4	4	92	GP
	2	3	22	14	64	GM		10	11	14	28	58	GM
	5	6	21	31	48	GM		14	15	4	11	85	GP
	6	7	16	34	50	GM		15.5	16	5	15	80	GP
	9	10	28	30	48	GM		16	17	29	9	62	GM
	13	14	11	5	84	GM		18.5	19	7	25	68	GP-GM
	16	17	44	26	30.8	GM	BH6	1	2	22	63	15	SM
	17	18	32	23	45.2	GM		2	3	19	81	0	SM
	20	21	46	44	10.8	GM		3.5	4	19	7	74	GM
	22	21	48	40	11.5	GM		5	6	13	26	61	GM
BH2	2	3	5	6	89	GP-GM		8	9	9	25	66	GP-GM
	3.5	4.5	49	38	13	GM		9.5	10	4	4	92	GP
	5	6	1	1	98	GP		12.5	13	8	24	68	GP-GM
	6.5	7.5	48	44	8	GM		14	15	4	11	85	GP
	8	9	1	0	99	GP		15.5	16	5	15	80	GP
	9.5	10	42	49	9	SM		18.5	19	10	27	63	GP-GM
	15	16.5	0	91	9	SP		19	205	7	25	68	GP-GM
	18. 5	19.5	25	39	36	SM	BH7	0.5	2	61.5	28.5	0	CL
	19.5	20	0	91	9	SP		2	3	54.9	45.1	0	CL
BH3	0	0.5	7	93	0	SP-SM		3.5	4	12.1	6.1	81.8	GM
	2	3	1	99	0	SP		4	5	14.3	8.1	77.6	GM
	3.5	4.5	4	96	0	SP		5	6	5.5	2.1	92.4	GP-GM
	5	6	10	58	32	SP-SM		6.5	7	13.9	6.6	79. 5	GP-GM
	8	9	13	24	63	GM		7	8	3.3	0.9	95.8	GP
	10	11	12	3	85	GM		8	9	9.7	3.7	86.6	GP-GM
	14	15	16	37	47	GM		9.5	10	6.2	11.6	82.2	GP-GM
	15.5	16.5	45	55	0	SM		10	11	1.1	1.0	97.9	GP
	19.5	20	45	41	14	SM		11	12	3.5	1.4	95.1	GP
BH4	0	0.5	1	63	36	SP		13	14	0.8	0.4	98.8	GP
	0.5	2	0	61	39	SP		14	15	3.9	7	89.1	GP
	3	3.5	0	40	60	CL		15.5	16	6.9	11.2	81.9	GP-GM
	3.5	5.5	11	85	4	SP-SM		17	18	3.5	3.8	92.7	GP-GM
	5.5	6.5	2	1	97	GP		18.5	19	0.8	1	98.2	GP
	6.5	7	10	8	82	GP-GM	BH8	0.5	2	35	65.	0	SM
	7	8	9	13	78	GP-GM		3	4.5	4.5	32	53	GM
	8	9	4	5	91	GP		4	5	22	47	31	SM
	9.5	10	13	27	60	GM		5	6	12	22	66	GP-GM
	10	11	5	53	42	SM		6.5	7	20	47	33	SM
	11	12.5	4	6	90	GP		7	8	16	38	46	GM
	15.5	18.5	4	1	95	GP		8	9	30	70	0	SM
	18.5	20	3	2	95	GP		9.5	10	6	5	89	GP-GM
BH5	0	1	22	58	20	SM		10	11	31	24	45	GM
	1	2	22	63	15	SM		12.5	13	2	2	96	GP
	2	3	19	81	0	SM		14	15	6	7	87	GP-GM
	3.5	4	7	19	74	GP-GM		15.5	16	6	4	90	GP-GM
	4	5	16	42	42	GM		16	17	9	8	83	GP-GM
	5	6	13	26	61	GM		17	18	11	4	85	GP-GM
	6.5	7	8	21	71	GP-GM		18.5	19	7	3	90	GP-GM
	7	8	6	16	78	GP-GM		22	23	70	14	16	GM
	8	9	9	25	66	GP-GM		24	25.5	16	13	71	GP-GM

Determination of Some Geotechnical Properties of the Soil at the Study Area by Using N-Values

Some geotechnical properties of site soils were calculated by using corrected N-values (penetration resistance values).

Relative Density

Figs 11 and 12, show the relative density values for the soil at the dam site. The results indicate that increasing of N- value with depth due to increase in grain size and overburden pressure, which reduces pores and increases density. This reflects increasing relative density, because high relative density of soil show high strength to penetrating the cone and requiring more blows to penetrate it down. Relative density is best evidence of compactness; there is a positive correlation between the relative density and ultimate bearing capacity.

Angle of internal friction

Figs 11 and 12, show the calculated friction angle (Ø) values based on the N-values at study area. Results show that the values of friction angle at BH-1, BH-2, BH-3, BH-4, BH-5, BH-6, BH-7,and BH-8 range between 27.7º at the depth 0-1in BH-1 to 45º in BH-1,BH-2,BH-3,BH-4,BH-5,BH-6,BH-7 and BH-8 . It is observed that the friction angle values are increased with increasing of depth. ,the friction angle is a function of the characteristics like particle size, compaction effort and applied stress level [8]. Friction angle also increases with the increase in angularity and surface roughness [9] which reduces pores and increases density.

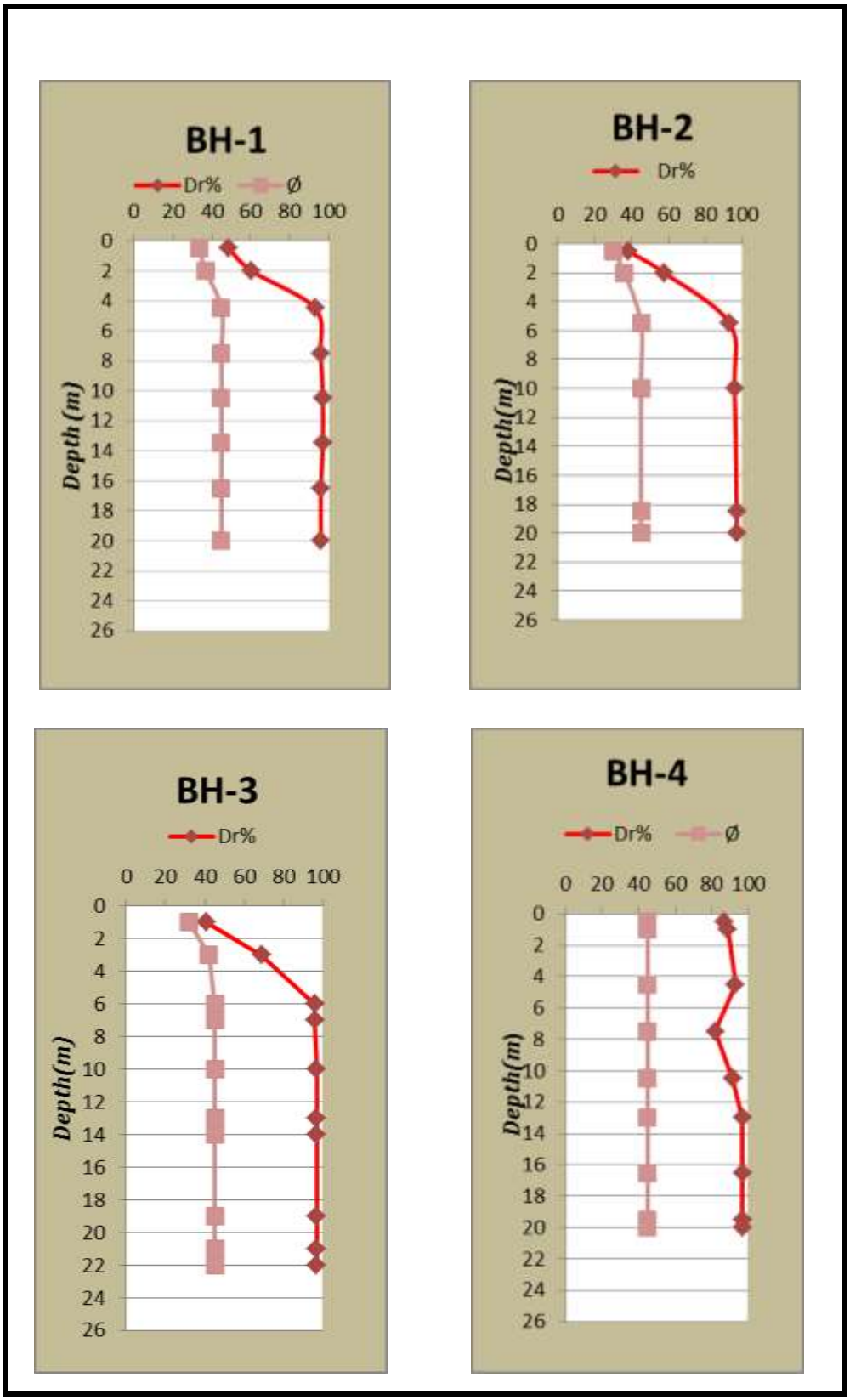

Fig. 11 Relative density and internal angles of friction values at dam site,BH-1,BH-2,BH-3 and BH-4

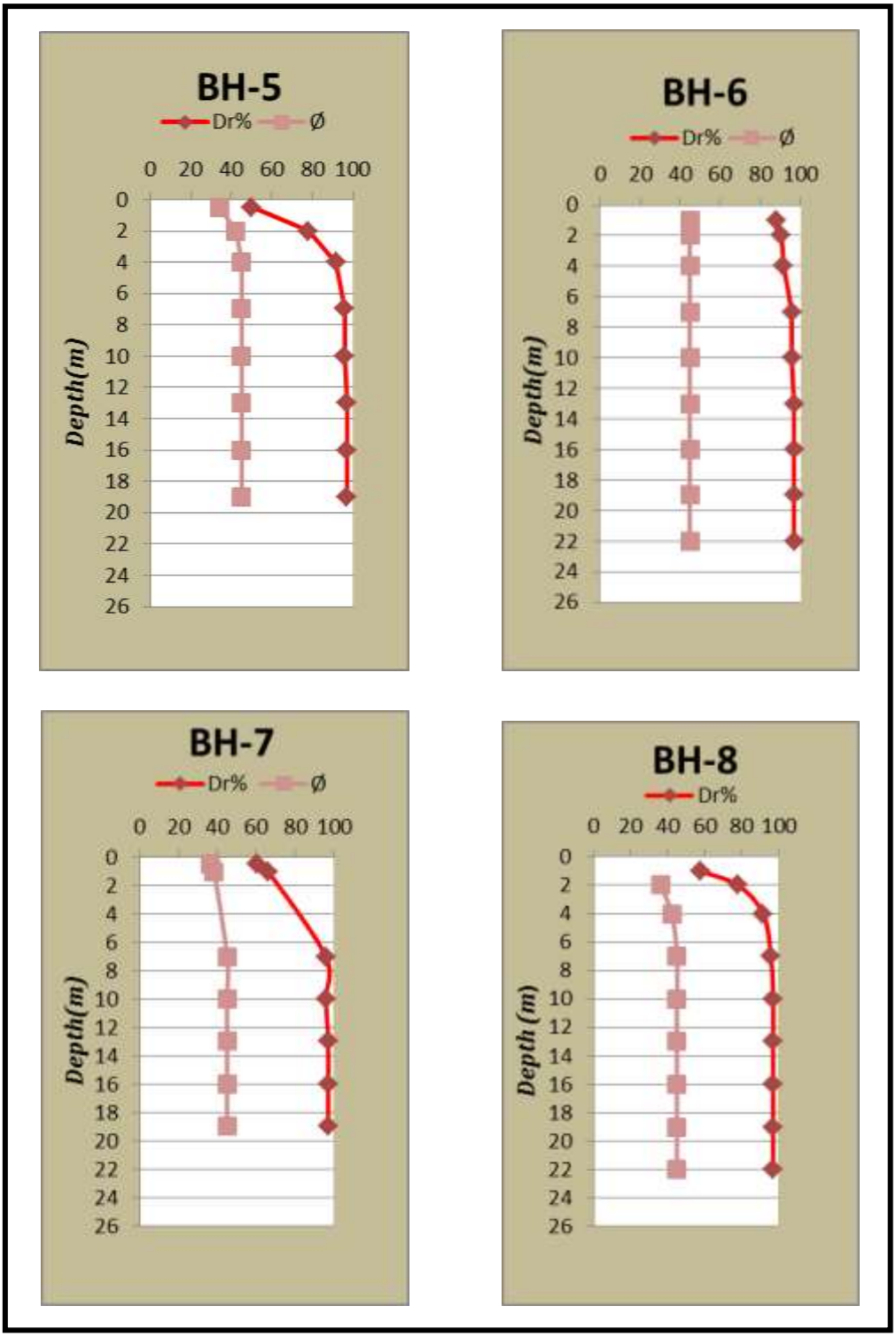

Fig12 Relative density and internal angles of friction values at dam site, BH-5,BH-6, BH-7 and BH-8

Conclusion

The following conclusions could be drawn from the study:

1. Analysis of the results of SPT values after correction and laboratory tests show that the soils at dam site can be classified into Medium dense silty sand (SM), Dense silty gravel with sand (GM) and poorly graded sand (SP), Very stiff silty clay (CL),and very dense silty sand(SM) and silty gravel with sand (GM).

2. The soils in dam site are sufficiently resistance mostly over 100 blows of SPT, The allowable bearing capacity of the site is adequate after removing the shallow surface layer up to 5 m.

Recommendations

1. The Standard Penetration test values have to correct due to the fact that the obvious effect on the accuracy of the results of the investigations, and the determination of the type and depth of the bearing capacity stratum.

2. Interest to the accuracy and experience of the soil investigation team and train them to avoid error at work.

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التقييم الجيوتكنيكي لموقع سد الطيب المقترح في محافظة ميسان

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المستخلص

استخدمت نتائج قيم فحص الاختراق القياسي (SPT) لوصف وتقدير قوام التربة المتماسكة، وتراص التربة غير المتماسكة للسد الطيب، يقع سد الطيب المقترح على نهر الطيب شمال شرق محافظة ميسان ،لجمع وتنظيم مياه الفيضان في فصل الشتاء ولتغذية المياه الجوفية . نتائج فحص الاختراق القياسي استخدمت في حساب الكثافة النسبية وزاوية الاحتكاك للتربة بعد تصحيح قيم الاختراق القياسي . اذ تراوحت قيم الكثافة النسبية بين (38-96)% ،وقيم زاوية الاحتكاك الداخلي تراوحت بين (27.65-45).صنفت طبقات السعة التحميلية في موقع السد المقترح اعتمادا على قيم الاختراق القياسي الى اربعة طبقات رئيسية ،طبقة الطينية الغرينية القوية جدا (CL) ، طبقة الرمل متوسطة الكثافة الردي التدرج (SP)،طبقة الحصى الكثيف الردى التدرج (GP) ،وطبقة الحصى الكثيف جدا الردي التدرج المخلوط مع الرمل.

الكلمات المفتاحية : اختبار الاختراق القياسي ، الكثافة النسبية، زاوية الاحتكاك الداخلي