

Role of Clay Content and Liquid Limit in Assessing the Liquefaction Susceptibility of Fine Grained Soil

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Abstract - This paper puts light on the role of clay content and Liquid limit in regarding a sample of soil as liquefiable or Non-liquefiable. Liquefaction susceptibility of fine grained soil is one of the important thrust area in the world of Geotechnical Engineering. A lot of research has been done by a lot of researchers over the last 45 years on this vary topic, different researchers have used different approaches and criterions to determine the liquefaction susceptibility out of which Modified Chinese Criteria has been used in this study. This study has been undertaken in the city of Jabalpur, samples of soil have been collected from 20 locations at different depths and tested in the laboratory for Liquid limit, Plastic limit, Grain size distribution, DFS, NMC and calculation for Plasticity Index has also been done and liquefaction susceptibility of soils of various locations is determined through Modified Chinese Criteria given by Andrews & Martin in the year 2000.

INTRODUCTION

Liquefaction is an amazing phenomena in which soil flows like water, evolution of gases takes place. This has been observed that liquefaction occurs generally in association with an earthquake, its spatial impact can be felt widespread. Liquefaction is transformation of granular material from solid state into liquefied state with a significant increase in pore water pressure until effective stress reaches to zero. It is evident from the cases of liquefaction that a lot of destruction is caused due to this. So, this phenomena has become a matter of attraction for the researchers all over the world. The layers of liquefaction are getting unfolded day by day yet there is a lot of scope for further unfolding as complete understanding of the phenomena hasn't been achieved specially for the fine grained soil. Researchers have developed criterions to study liquefaction susceptibility of fine grained soil taking various parameters. This has been found that clay content and Liquid limit are the key parameters influencing the susceptibility of soil towards

liquefaction. Jabalpur is a fast developing city and multistory buildings are also emerging in the city now. On the other side, cases of liquefaction were also reported in the city during the earthquake of 22nd May, 1997. So, the knowledge about liquefaction susceptibility of the city is the need of time in view of these facts this study is undertaken.

LITERATURE REVIEW

Efforts of researchers are continued since last five decades in order to find liquefaction susceptibility of soil and factors responsible for this amazing phenomena.

In this line, kishida (1970) studied grain size distribution of boils ejected at Nanaeham Beach Japan during the 1968 earthquake at Tokachiki. He found that boils consisted of sandy silt with clay content less than 10%. Similarly Wang (1979) showed that 15% of clay content as a cut off to liquefaction of soil. Zhou (1981) conducted detailed study of liquefaction occurred during the Tangshan earthquake of 1976 in China. He conducted particle / grain size distribution analysis of soil of various layers and conducted that clay content must be less than 10%. Similar Studies were under taken by Tokimatsu & Yoshini (1983) and Tuten et al. (1990). Seed & Idriss(1982) took Wang's work as a basis and developed popular Chinese Criteria which states that a soil containing (a) less than 15% clay fraction (finer than 0.005 mm) (b) Liquid limit less than 35% and (c) Water content higher than 90% LL.

Later, Andrews & Martin (2000) modified the existing Chinese criteria and thus, modified Chinese criteria came into existence. Morto & Soon (2012) reviewed many approaches of assessing liquefaction susceptibility and considered modified Chinese Criteria acceptable globally and according to ASTM international.

MATERIALS & METHODS

Jabalpur city is taken as the area of this study. This city is located in the central part of Madhya Pradesh on the bank of river Narmada (23°09'57.8"N & 79°05'57.5" E) at an elevation of 411 meters.

Twenty locations as shown in Fig. 1 were selected randomly in the entire city for this study. Samples of soil were collected from different depths at each location. Analysis of the samples was undertaken at the Geotechnical laboratory of Jabalpur Engineering College for Liquid limit, Plastic limit, DFS, NMC and Grain size distribution as per the relevant I.S code of practice.

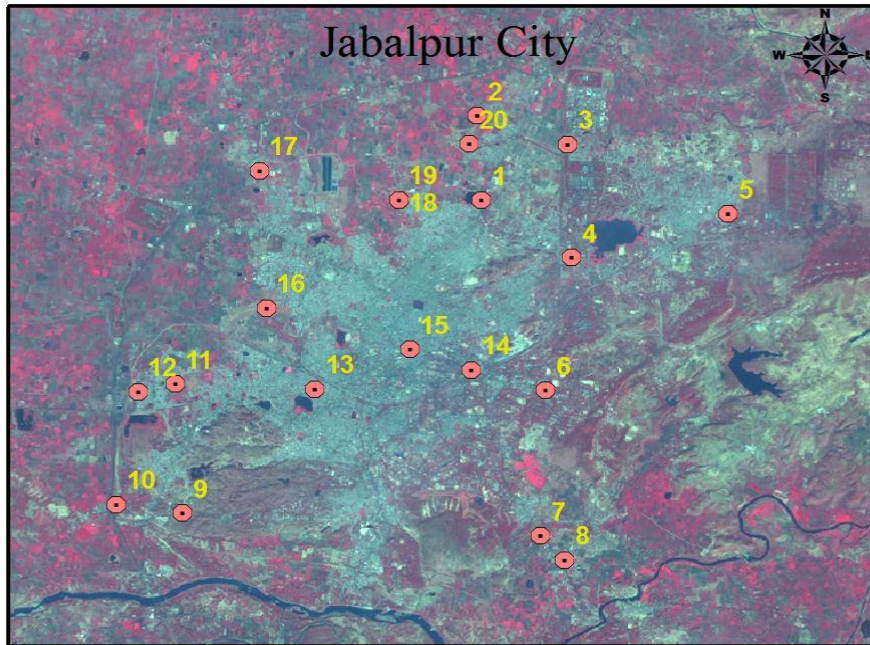


Fig. 1 Map showing the sampling stations

(Source : Google Earth)

Table:-1 Description of sampling stations

S.No.	Location	Latitude	Longitude	Altitude(in ft)
1.	Housing Board colony Maharajpur	23°12'29.5"	79°57'14.1"	1254
2.	Maharajpur	23°13'46.6"	79°57'07.3"	1264
3.	Richai	23°13'24.4"	79°58'28.5"	1254
4.	Shobhapur	23°11'40.2"	79°58'30.7"	1256
5.	Khamariya	23°12'19.8"	80°00'50.3"	1316
6.	Science collage	23°09'41.4"	79°58'18.8"	1356
7.	Bilehri	23°07'33.3"	79°58'05.5"	1332
8.	Tilehri	23°07'09.8"	79°58'27.5"	1331
9.	Bargi hills	23°07'50.5"	79°52'54.7"	1367
10.	Sagda	23°07'57.5"	79°57'57.0"	1308
11.	Bhookamp colony	23°09'45.0"	79°52'45.2"	1271
12.	Dhanwantri Nagar	23°09'36.1"	79°52'45.2"	1268
13.	Kalimath	23°09'43.1"	79°54'48.3"	1274
14.	Railway station	23°09'57.8"	79°57'65.5"	1330
15.	Victoria	23°10'18.2"	79°56'9.7"	1301
16.	Vijay Nagar	23°10'54.2"	79°54'04.4"	1246
17.	Karmeta	23°12'54.9"	79°53'57.6"	1235
18.	Amkhera	23°12'29.9"	79°56'00.0"	1238
19.	Krishi Nagar Colony	23°12'30.0"	79°55'59.9"	1209
20.	Suhagi	23°13'19.4"	79°57'00.9"	1246

Liquefaction susceptibility of soils of the study area was ascertained on the basis of criteria suggested by Andrews & Martin (2000), popularly known as the Modified Chinese criteria given below in Table 2.

Table 2: Modified Chinese Criteria

Clay Content (<0.002 mm)	Liquid Limit <32%	Liquid Limit >32%
< 10%	Susceptible	Further studies required (Considering plastic non-clay sized grains)
> 10%	Further studies required (Considering plastic non-clay sized grains- mine and quarry tailings)	Not susceptible

Notes:

1. Liquid Limit determined by Casagrande-type percussion apparatus
2. Clay defined as grains finer than 0.002mm

Based on this criteria, each sample was classified as susceptible/Not susceptible & Further studies required.

RESULTS & DISCUSSIONS

In order to determine liquefaction susceptibility of the soil of Jabalpur city sampling was done at twenty various locations. Liquid limit, Plastic limit, Particle size distribution, DFS & NMC were determined using the relevant code of practice in the departmental laboratory taking Modified Chinese Criteria as the deciding criteria. Susceptibility to liquefaction of the soil of study area is ascertained and presented in Table 3.

Table:-3 Liquefaction susceptibility of the soil at the selected stations & depths.

S.No.	Loaction	Depth	Clay content	Liquid Limit	Remark
1.	Housing Board colony Maharajpur	2m	39%	50.75	Not susceptible
		3m	36%	39.5	Not susceptible
2.	Maharajpur Basti	2m	40%	46.5	Not susceptible
		3m	35%	40.25	Not susceptible
		4m	18%	29.1	Not susceptible
3.	Richai	2m	34%	64.22	Not susceptible
		3m	32%	62.06	Not susceptible
4.	Shobhapur	2m	40%	48.2	Not susceptible
		3m	39%	46.78	Not susceptible
5.	Khamariya	2m	39%	42.32	Not susceptible
		3m	34%	46.35	Not susceptible
6.	Science College	2m	9%	24.9	Susceptible
		3m	17%	40.6	Not susceptible
7.	Bilehri	2m	35%	60	Not susceptible
		3m	33%	55	Not susceptible
8.	Tilehri	2m	40%	57.8	Not susceptible
		3m	34%	56.6	Not susceptible
9.	Bargi Hills	2m	4%	30.6	Susceptible
		3m	No clay	34.92	Further studies required
10.		2m	31%	54.64	Not susceptible

	Sagda	3m	32%	55.01	Not susceptible
11.	Bhookamp colony	2m	42%	70.92	Not susceptible
		3m	36%	55.6	Not susceptible
12.	Dhanwantri Nagar	2m	36%	64.22	Not susceptible
		3m	32%	62.06	Not susceptible
13.	Kalimath	2m	15%	27.9	Further studies required
		3m	14%	30.67	Further studies required
14.	Railway Station	2m	32%	35.9	Not susceptible
15.	Victoria	2m	17%	36.48	Not susceptible
		3m	9%	37.8	Further studies required
16.	Vijay Nagar	2m	40%	56.47	Not susceptible
		3m	38%	54.65	Not susceptible
17.	Karmeta	2m	42%	58.03	Not susceptible
		3m	45%	64.95	Not susceptible
18.	Amkhera	2m	23%	65	Not susceptible
		3m	7%	25.17	Susceptible
19.	Krishi Nagar colony	2m	30%	52.1	Not susceptible
		3m	31%	48.99	Not susceptible
20.	Suhagi	2m	42%	51.35	Not susceptible
		3m	43%	56.2	Not susceptible

It is clear from Table- 3 that soils of Amkhera at 3m depth and Science College & Bargi Hills at 2m depth are found to be susceptible to liquefaction. Soils at Victoria & Bargi Hills at 3m depth are recommended for further studies.

Kalimath remains the only location where soil at 2m as well as at 3m are recommended for further studies.

CONCLUSION

Large area of Jabalpur city is not susceptible to liquefaction. The samples collected from the areas of Amkhera at 3m and Science college & Bargi Hills at 2m depth showed susceptibility to Liquefaction.

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