

## Role of Sedimentary Changes and Groundwater Level in Liquefaction of the South of Tehran

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### ABSTRACT

Tehran city located on the large alluvial fans in recent decades due mainly to the north of the Alborz mountain range located south east and west has trend of industrial development and population growth spawned the development high buildings also in southern parts of has created change the size sediments from north to south and also the water level underground in conditions, event, earthquake-possibility to create phenomenon, Liquefaction take probable, makes. This paper has attempted to examine the geology of the site with the use of boreholes and geotechnical characterization of sediments and soil mechanics changes in groundwater level as well as liquefaction potential was evaluated results showed that different parts of the south of Tehran, was susceptible to liquefaction, Using dynamic analysis of potential risk zones on the verge of separation and liquefaction areas were also identified. These areas at depths less than 20 m below ground water surface and fine-grained sediments are non-cohesive.

**KEYWORDS:** liquefaction, risk zonation, geotechnic, Tehran, soil mechanic.

### 1-INTRODUCTION

Due to Tehran's position and the presence of active faults near the southern Pediment of the Alborz around them, continuously recorded earthquakes in the seismic network around the city and the devastating earthquake in the history of the seismic potential is high[2]. Studies in this direction, as attested by the high probability destructive earthquake occurred in the metropolitan area in the not too distant future in addition, the uneven growth of Tehran especially in recent decades has led these cities against possible earthquake high vulnerability [5and6]. Construction of boundary faults and areas prone to the geologic instability no attention to the intensity of seismic Tehran The design and operation of buildings and critical facilities Uneven distribution of facilities and amenities needed in times of crisis, Despite numerous and diffuse tissue vulnerable and aging In the city, and many others, all show that In the event of a severe earthquake in Tehran Irreparable loss and injury partly will to be. In order to reduce seismic risk required in Tehran while recognizing the earthquake and seismic vulnerability of Tehran with purposeful planning, realistic and holistic perspective measures to reform the city and achieve sustainable development done [11]. The first step in this direction is to recognize existing too according to the study design and follow-up actions should be complementary. So one of the important steps in this regard recognizing the condition of the earth and site development projects .The geotechnical properties of cholera in southern Tehran Occurrence of liquefaction of the ground conditions likely to exacerbate the groundwater level. In this paper we are considering the possibility of showing geological conditions geotechnical borings to identify areas prone to liquefaction.

### 2-Geology and geomorphology of Tehran

Tehran in the Alborz mountain range in the south is located and north of the central Iran plain is considered. Alborz mountains in north of Tehran, consisting of series of folds and thrust fault east - west from the center outwards Alborz (North and South) have been driven.

Deformation of the two sides of the north (Alborz fault) and South (North Tehran fault) has reached its maximum height of the Alborz mountain range in the North Sea, respectively, on the plain side and plain on the south of Tehran is pushed.

Topography of the Tehran is plain with mountains and slopes from north to south by depression east - west is divided into different sections. Tehran and its surrounding area from north to south can be divided into several sections [5]:

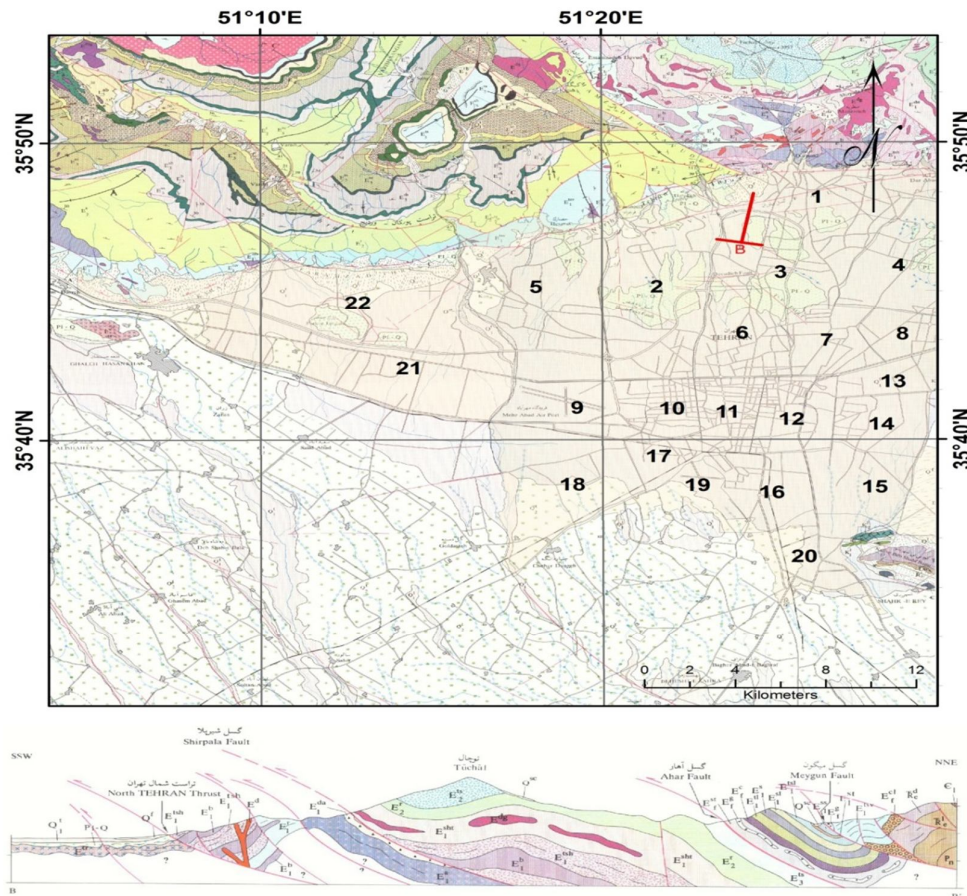
- High Alborz
- Alborz border folds
- Pediment zone of Tehran
- North central Iran depression (Tehran - Ray Plain)

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**2-1-Alluvial Tehran's range:** Generally Tehran and the surrounding area have been built on young alluvial deposits. These sediments have been studied by many researchers [1, 2.5, and 18]. Alluvial deposits in southern Tehran desert stretches from the Alborz Mountain, extending the seasonal flooding of rivers and streams of the foothills of the Alborz Mountains (Fig.1). The alluvial sediments generally "have been divided into four parts [5]:

- 1) Formation A (formation of Hezardarreh).
- 2) Formation B is two different stratigraphic units have been assigned to formation of Bn (heterogeneous alluvial formations of northern Tehran) and formation of Bs (silt or clay formations south of Tehran or Kahrizak formation).
- 3) Formation of C (alluvial formation Tehran).
- 4) Formation of D (recent alluvial deposits) Generally, D build two different stratigraphic units D1 and D2 division is called. Unit of D1 (alluvial formation of Khorramabad), representative of alluvial deposits in southern of Tehran are the present Covenant and Testament of alluvial deposits of D2 agents are present in northern of Tehran. (Berberian et al-1993).

**2-1-1- A formation (formation of Hezardarreh):** The oldest alluvial deposits called Hezardarreh Formation know that the ranges Evin, Gheytarieh, Abbas Abad District Lavasan pass Qochak and form deep valleys of tall hills spreading. The name of this formation is chosen according to the nature of morphology. No unconformity in southeast Tehran to formation of Hezardarreh is located on Upper Red Formation, and the boundary between the two formations is gradational. Documents and evidence are set at the time of formation of alluvial sedimentation and erosion by Hezardarreh of Alborz mountains were raising. After folding A formation, faulting and erosion, with formation of unconformity by heterogeneous alluvial north of Tehran and is covered Kahrizak formation. Formation of Hezardarreh is made of a homogeneous conglomerate with pebbles, sand, is composed of sand and silt has filled the space between the grains. Fluvial flood the workforce is the main rivers feeding morphology, but it is unclear at present [4 and 19].



**Fig 1-**Geological map and section of Tehran region [19]: cross section show folding and thrust fault in the north of Tehran, and alluvial deposits in south.

**2-1-2- B formation:** Sediments of Plio -Pleistocene and Early Quaternary alluvium in the Tehran area B formation are known by name in two different areas with different facieses are observed. These two facieses can be divided into northern and southern facieses. [5 and19]: Formation of Bn (heterogeneous alluvial formations of northern Tehran) B represents the alluvium in the northern parts of Tehran. Sedimentology characteristics of the alluvial deposits in northern Tehran ingredients are not the same size and heterogeneous mixture of sand, gravel, and cobble rocks and stones and clay pieces and sometimes large blocks scattered that it is incongruous with clay and sand. Mountainous areas of north of Tehran this heterogeneous alluvial deposits are called the (North Tehran Heterogeneous Alluvial Formation) are known. Bn formation uncomfortably on the eroded surface and has been folded to thousands of valley. Bn cannot be applied in a way down to A formation level is located on the north of Tehran and alluvial fan topographic forms.

Formation Bs (silt or clay formations south of Tehran, Kahrizak formation) B represents the southern parts of Tehran alluvium is composed of the alluvial facies in the south of Tehran and Silt, clay materials that are known to Kahrizak formation. Bs formation is so widespread in the plains south of Tehran and Ray is extensive. Bs formation outcrops in the fault are detected, there are quasi-compact. Terms of Geotechnical Engineering, outcrop may make are the same with some parts of C formation.

**2-1-3- Formation of C (alluvial formation Tehran):** Tehran formation alluvial or alluvial fan C consists of young alluvial deposits of the southern slopes of the Alborz that has continued to the south of the plain is covered. Large part of Tehran city is built on alluvium. These are generally not the kind of river sediments and alluvial fans are formed. The majority of the erosion and sediment alluviums heterogeneous formations north of Tehran's Kahrizak have been obtained. The formation is located in heterogeneous formations north of Tehran and is present on the alluvial. The formation C is formed of young alluvial fan deposits made of Conglomerate. This formation consists of conglomerates homogeneous, composed of sand sized gray to brown sand, which is sand and silt-sized matrix. Located in the north part of the city, Tehran's alluviums are of large-grain type. In other words, in the more northern areas of the deposits containing layers of sand and rubble that the inter laminar it be and whereas south of Tehran and around of Ray city at the time of formation of these deposits exposed floodwaters was in the stream most of the western highlands and mountain ranges tripod Bibishahrbanoos launched its Alluvial plain Ray was wide kilometers. In addition, at the time of the Kan River flood waters continued to Kahrizak. Because of this long-distance transport in the south of Tehran, Tehran alluvial deposits consist of fine-grained materials [4,5and 19].

**2-1-4- Unit D (alluvial formation of Khorramabad):** Unit D1 (alluvial formation of Khorramabad) south of Tehran now has vowed to represent alluvium. These units cover Bs in many parts of southern Tehran and its topography comprises a single pen plain. This unit consists of fine silt and clay with brown and gray color is cream and in some places it is sandy and gravelly. Essentially sand sediments are the richer parts of north and east of plains. Fine grain materials such as silt and clay are in the southwestern part of plain the main stream. and there is no single indicator of bedding. Fluvial facieses equivalent of a slightly older unit is considered the area north of Tehran. The age of unit is less than 4000 years (Holocene) [5].D2 unit is consisting of the pyroclastic with size of weakly consolidated sand with weak to non-consolidated silt and sand-sized matrix. This unit has been painted gray to dark gray alluvial and fluvial origin, similar to C formation. However, the lack of cementation, low density and lack of iron oxide segments can be difficult to make it easy to distinguish C formation. This unit is less than formation of C is difficult. Active floodplains and alluvial fans and young alluvial fan D2 unit has been established in northern of Tehran. Rock units are older alluvial Hezardareh (alluvium of A formation) bedrock known as the Tehran area.

### **3-Neo tectonics Studies**

Neo tectonics survey is part of a study tectonic crustal deformation associated with the young. Careful analysis of the results of such examination to the formation of structures, young, old structures of deformation in the current environment and identify the current drought situation prevailing in the region, leading. Neo tectonics Studies, especially in seismic active areas of land that are associated with a wealth of information and level of seismicity and seismic potential of the region loses immunogenicity structures [2 and11]. Unlike plans offered by various individuals and research centers range for faults in Tehran, Iran, Neo tectonics few studies to determine how the activity of these faults was conducted.

Neo tectonics of the first studies on the range of faults Tehran by Hesami (1994) at the International Institute of Seismology and Earthquake Engineering Seismology long as the investigation is on the Kahrizak fault [8]. Reviews of ancient earthquake fault zones on Eipak fault North Eshtehard morph tectonic and long seismology studies on the eastern Mosha fault, corrosion China Neo tectonics range of Tehran, Tehran-wide survey Neo tectonics and tensions surrounding major faults, and Geodynamics of the Central Alborz range in Iran and Tehran is the most important studies neo tectonics range[1,3and18].

### 3-1-Neo tectonics stress situation in the area around Tehran and major faults:

Identification mechanism and kinetic analysis of current faults and tectonic structures requires understanding the tectonic regime prevailing in the region and more precisely is neo tectonic stress field. Three methods commonly used to determine the geometry of the structural elements of neo tectonic stresses young seismotectonic studies and determination of compression and tension centered on solving the focal mechanisms of earthquakes and tectonic crustal movements are measured [11,12and14]. The easiest and most economical method for accurate estimation of the neo tectonic stress, field measurement techniques and the tectonic structure; the earthquake was the most important devices used to limit the seismotectonic and geodynamic measurements of the shell is a high cost [6and8].

Abbasi and Shabani (1999) and Abbasi et al (2002) method of tectonic stress Neo tectonics in Tehran and its surrounding area and to determine the kinetic analysis of the faults that have been around [1,12and14]. Neo tectonics and stress state on the southern edge of Central Alborz paleo stress shows. The results of this study show that the stress varies Neo tectonics in central Alborz. West Branch (Tehran - Qazvin) main stress direction is N40E and becomes to N30E, closer to the plains. The eastern branch (Semnan - Damghan) to the northwest and along the principal stress direction is N61W. Clockwise rotation of the axis of maximum stress range in Tehran until after folding Hezardarreh formation shows the evolution of the stress field in north west - north, south and northeast [3and14]. Major faults in the western part of central Alborz are sinistral strike-slip mechanism parallel and Taleghan with the main stress direction N40E is consistent. The stress ellipsoid obtained for the various stations along the Mosha fault, this fault can be divided into two parts, East (Kahank to the northeast of Tehran) and west (north-east of Tehran to Shahrestanak) can be assigned. Strike-slip faults in the eastern part of the dominant tectonic regime that is consistent with the morphological evidence. Specifically, this part of the Mosha fault their young tectonic activity shows [18]. Tectonic regime changes the strike-slip fault in the western part to the pressure active fault. Approaching the desert and changing the direction of the principal stresses as Pishva active faults, Avaj earthquake fault with sinistral strike-slip mechanism could be reversed with a small component. The eastern branch of the Central Alborz fault threshold with the general trend northeast - southwest dextral would have strike-slip mechanism. Approaching the western parts of Semnan active faults are dextral strike-slip with a small component of reverse mechanism [1]. Seismic classification of the sub-zonation of Tehran by the Japan International Cooperation Agency (JICA) and the Center for Earthquake and Environmental Studies of Tehran by Tehran municipality began April 1998 and was completed in September 1999. This study aimed to map the seismic classification of the sub-zone of Tehran and provide recommendations to mitigate the effects of the crisis have been done [12]. Earthquakes analyzed in this study, the following steps are taken:

- 1 - Decide on a scenario earthquake.
- 2 - Design a fault model for numerical computations.
- 3 - Analysis of the earthquake using the empirical Green's function.
- 4 - Production engineering of seismic wave the bedrock synthetic form.
- 5 - Calculate the magnification factor alluvial soil classification and analysis of the response.
- 6 - Get the surface wave on the ground.

**3-1-1- The analytical method:** For the estimation of strong ground motion, the analytical method used. Given that many of the faults of Tehran in the category of active faults are classified as quaternary geology. A hypothesis based on the most destructive scenario approach as a basis for assessing the vulnerability of the city and the inevitable earthquake is considered. To determine the characteristics of earthquake fault scenarios that were used in the design of the most dangerous faults in Tehran were as follows:

- Mosha fault
- Northern Tehran fault
- Southern ray fault
- Float model

**3-1-2-Fault Model Parameters:** The length and direction of each fault surface traces of faults in the model have been determined. Over half of the model's ray model is considered as the model for the models hidden. Using the empirical relationship between the width and magnitude of the reverse faults by Cuper Smite by Wells (1994) proposed using the length is calculated Deep [8]. Upper edge parallel to the fault model and zero kilometers north Tehran fault and Mosha fault model and fault model assumed is 5 km float model, because the bedrock is deeper from north to south. In Table 1 the parameters of the fault model are presented [11and12].

## 4-METHODOLOGY

General framework for studies in this area can be summarized as follows:

- Geotechnical data collection requirements contained.

- Geotechnical field and laboratory.
- Seismic and seismic surveys studies.
- Estimation of strong ground movement on seismic bedrock.
- Provide analysis of geotechnical and seismic profiles alluvial type.
- Classification and results of the sub-zone maps.

It should be noted that the studies conducted in scheduling sub-zone of north Tehran, according to the standard procedures of the studies have been conducted as a one-dimensional and the effects of topography on strong ground motion are ignored. Preliminary studies have been conducted in order to evaluate the effect of topography on earthquake ground-level characteristics show this effect is not noticeable in northern Tehran.

**Table 1-Parameters of fault model**

Fault model specifications	Ray fault model	North Tehran fault model	Fault model Masha	The float model
Length (km)	26	58	68	13
Width (km)	16	27	30	10
(Mw) magnitude of torque	6.7	7.2	7.2	6.4
(N) ° North	35.8255	35.6815	35.5876	—
(E) ° South	51.7392	52.4955	51.5061	—
Direction (clockwise from north) (deg.)	263	263	283	263
Float model inclination angle (°)	75	75	75	75
The depth of the bottom edge (km)	5	0	0	5

In the present studies to consider the effects of surface and subsurface topography on strong ground motion characteristics (numerical and experimental studies) in the form of research projects at the Institute of Seismology.

**4-1- Collect the necessary information available:** The initial phase of the study and collection of resources and the returns available in the Geotechnical Data collection has been completed. At this stage of the Geotechnical Data Speculation about 380 locations in 1100 to collect, organize and process information was obtained from geological mapping, Mapping groundwater level and its changes, and provide the representative profiles are used to analyze the seismic response of alluvium. Figure 3 shows the spatial distribution of this information.

**4-2- Geotechnical studies (field and laboratory):** At this point approximately 760 meters of drilling has been conducted in 26 locations, Figure 3 These sondajs are located primarily in the areas of Geotechnical Data and lack of proper distribution in the southern area have been studied. During drilling operations, obtaining disturbed samples (238 samples) and intact (86 samples) and the requirements of the Standard Penetration Test (233 Tests) have been on the agenda. In order to scrutinize the results of drilling and dynamic behavior of the curves derived soils of southern Tehran, laboratory tests, such as aggregation (315 tests), one-dimensional consolidation (14 tests), density (7 trials) and density (66 tests) and cyclic tri axial tests, and (6 tests) and resonant column (11 tests) were performed.

**4-3- Experimental studies on seismic and micro-seismic survey:** This section studies the space requirements for seismic refraction experiments and also with respect to drilling operations a total of seismic refraction experiment at 95 locations within the central hole in 9th place in the whole range of studies that are considered with respect to the spatial distribution fairly good estimate of the distribution of shear wave velocities in different layers in the study area and the results of the shear wave velocity maps have been used in the Tehran area. In addition, the old ties to the relationship between shear wave velocity and SPT values for different soil types have been reviewed and deliberated on the results of representative profiles have also been used [9]. Also available in 123 locations and the uniform distribution in the range of micro-seismic survey was conducted to test Tehran the results for the period of natural stone floor seismic structure and depth control is used [7 and 17].

**4-4-Geotechnical and seismic profiles and sub-zone maps:** The dominant soils in the north to the south of coarse grain to fine texture and thickness change increases. Although the detailed geologic and engineering description of Tehran alluvium largely encompasses their specific features, introducing the geotechnical parameters of these alluviums however can provide for a more clarified image of their situation [1]. For this purpose, some of the geotechnical features of the alluviums extracted from the investigation of soil borings have been introduced in table 2.



Table 2- Some of the geotechnical parameters of Tehran alluvial field

Alluvium material	Soil type classification system in USCS	Dry specific weight (Kg/m <sup>3</sup> )	The ground reaction Module (Mpa)	Internal friction Angle - deg.	Young module (Mpa)	Cohesion (Mpa) cohesion- (Mpa)
Coarse-grained gravel relating to the A formation in northern Tehran	GC-GP-GM	1900-2200	3	37-30	120-80	0.02-0.1
Coarse-grained gravel relating to the B formation in northern Tehran	GC-GP	2000-1700	2	34-25	50-20	0.005-0.01
Coarse-grained gravel relating to the C formation in central and northern Tehran	GW-GC	2000-1800	1-2.5	40-30	80-40	0.01-0.03
Coarse-grained silt Relating to the D formation in central and southern areas	SP-SC	1900-1650	0.5-1	30-25	20-15	----
Fine-grained silt Relating to the D formation in southern areas	ML	1800-1600	0.4-0.8	20-15	30-20	0.015-0.02
Fine-grained clay in southern areas	ML-CL	1700-1500	0.2-.04	10>	25-10	0.01-0.04

**4-4- Sub-zonation classification based on normal cycle:** A significant portion of the alluvial deposits in northern Tehran has a natural period (wave velocity) of less than 1% per second. Deep sediments in the north of Tehran in the course of normal alluvial period of about 0.06 to a maximum of 0.15 seconds are the change [13]. In West and North West of the range of alluvial natural cycle 0.07 to 0.12 seconds in Jannatabad and East Azadi Stadium is calculated. East of the mountains and highlands Tehran Bibishahrbanoo lower sediment thickness and decreased amounts of normal menstruation. South Central part of the development of coarse sediment and shallow profile is consistent with the natural alluvial period of less than 15 of the second. Fine sediments in the southern part of the region based on seismic and geotechnical depth profiles of more than 30 meters, the range of normal menstruation was (0.30-0.40).

In the transitional period between the two sections above a normal bar (0.15-0.30) have the geology of the alluvial deposits of coarse to fine matching is the transition region. Move the natural period of alluvium in the southern part of the study area increased (0.45-0.60) was. Because of the considerable thickness of the layer of soil profiles with clay and silt is loose in the area. State deep seismic profiles in some places more than 40 meters is reached. The highway Azadegan limited to Shahid Rajai natural alluvial period of more than 0.6 per second. The presence of the weak clay layer at the surface alluvium is the natural period increases. Loose thickness in some areas more than 20 m and the shear wave velocity is measured at about 200 meters per second [12and17].

**4-5-Sub-zonation scheme based on dynamic period:** In this Sub-zonation classification maps as well as maps of the area in terms of natural alluvial period, dynamic period increases from north to south. Alluviums dynamic period in northern Tehran approximately 0.1 to a maximum of 0.43 seconds will change the course of a single network but other courses in the area of network units north of Tehran in the dynamical period of less than 0.3 seconds respectively, (In the period Subjects dynamic range 15-430 in the second) in the western zone of the study area increased dynamic period of menstruation natural alluvial and coarse texture because they are more difficult, and less than 0.16 is limited. In the southern part of Tehran, dynamic period in the lowest parts of central and southeast of the city has seen. The soil profile consists mainly of shallow coarse sediments that have high density and shear wave velocity. The edge of the tape and increase the depth and dynamic period of alluvial clay layer is increased. The most dynamic periods in the alluvial deposits in southern Tehran Azadegan, from intersection to intersection of highway Saeedi and Galehmorgi are in the castle. In some places, the alluvial dynamic period of more than 2 seconds are up.

The results of studies on the effects of the greater Tehran area that according to available data, both standardized and systematic series of studies have been described the process followed and the quality of these studies .Comparative evaluation conducted by the Institute of International Studies and JICA show that the reasons given above, Sub-zonation maps prepared by packing by research in the twenty-Tehran as a basis for further studies and applications can be used. Twenty-one and twenty-two regions in Tehran, it is recommended to conduct further studies, the JICA study's model assumes that the maximum acceleration at the surface of 0.3 g to 0.4 g is estimated to be used [11and12].

### 5-Liquefaction hazard assessment at different scales

Liquefaction assessment of the type and scale of a project may be carried out. In general, the studies reflected according to the instructions in "State of seismic hazard zonation [8] three small, medium and large scales are presented. Overall, the findings indicate that it is liquefaction areas of the three studies were carried out but we'll continue to focus on large-scale studies carried out in Tehran.

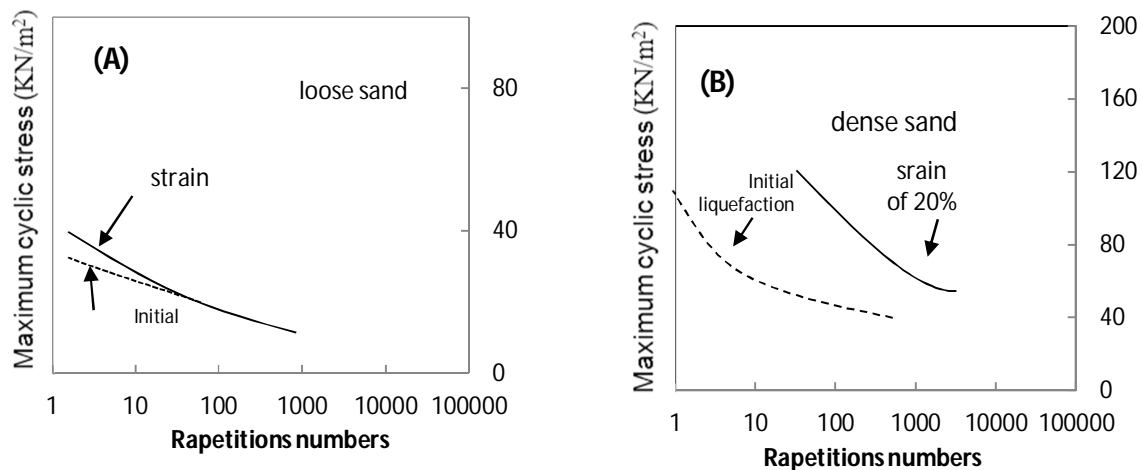
**A - Small scale studies (grade zoning):** These studies are mostly based on the information of liquefaction in past earthquakes and geology and geomorphology mapping takes place. Zoning scale studies degree usually ranges between 1:50,000 to 1:100,000

**B - Medium scale studies (degree zoning):** Careful study of this scale is higher than previous studies and the sources used in the study of aerial photographs; local studies and geotechnical assessment are reported. 1:25,000 to 1: 50,000 scale studies often vary.

**C - Large-scale studies (Third grade Zoning):** Risk assessment in large-scale studies, due to the Geotechnical analysis of soil layering according and field and laboratory tests are done. Scale studies are ranges 1:10000 to 1:25000. A simple method has been widely used in large-scale studies. In this method, liquefaction is determined locally at different depths the cyclic resistance of the soil on one side (CRR) desired depth using in situ tests and laboratory test results obtained. In addition, the cyclic stress induced at the same depth (CSR) due to possible earthquake characteristics (such as size and speed) and stress condition in the soil is calculated [13,15and16]. The factor of safety (F.S.) into the liquefaction resistance to shear stress by mass effect is achieved by an earthquake; the probability of liquefaction is studied in depth.

#### 5-1-The effect of various parameters on the liquefaction potential:

**5-1-1- Effect of initial relative density:** Figure 2 with initial relative density of the soil liquefaction is shown. For all the experiments shown in Fig are  $\sigma_3 = 98.1 \text{ KN/m}^2$  Liquefaction is a condition in which the initial pore water pressure equal to the confining pressure is provided  $\sigma_3$ . In most cases, the strain amplitude increased 20% to be considered as a point of failure Can be seen that for a given amount  $\sigma_d$ , initial liquefaction and failure for loose sands occur simultaneously (Fig. 2-A). However, the relative density increases, the difference between the number of occurrences for a periodic time of initial liquefaction, and high strain amplitude increased by 20%(Fig. 2-b)[16].

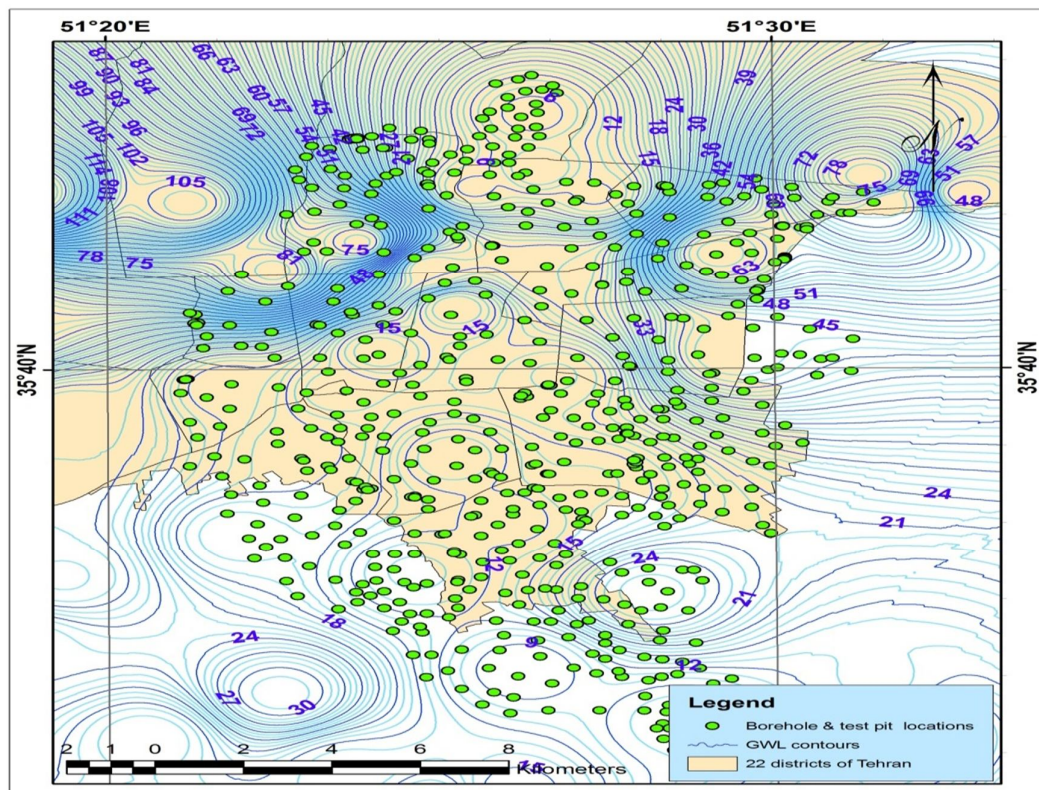


**Fig.2-**on the initial relative density of sand liquefaction Sacramento River; (A) The initial void ratio equal to 87/0, The relative density of 38% and  $\sigma_3 = 98.1 \text{ KN/m}^2$  (B) the initial void ratio equal to 61/0, the relative density of 100% and  $\sigma_3 = 98.1 \text{ KN/m}^2$  [16].

**5-1-2- The effect of confining pressure:** The effect of confining pressure on liquefaction  $\sigma_3$ 's initial conditions and double strain amplitude of 20% is shown. Density relative to the initial conditions and constant stress, the number of occurrences for a periodic time of initial liquefaction with 20% strain, pressure limiting, increases. This conclusion is true for the relative density [16].

**5-1-3- The impact of alternative offset maximum stress  $\sigma_d$ :** Changes the maximum deviator stress  $\sigma_d$  confining pressure for initial liquefaction in the 100 range and axial strain of 20% for the 100 range is shown, that note that for an initial void ratio (i.e., the initial relative density RD) and number of repeated cyclic load changes,  $\sigma_3$  against  $\sigma_d$  for initial liquefaction is practically linear. A similar relationship exists for the sand for a 20% axial strain.

**5-1-4- Groundwater contour elevation and mapping:** Liquefaction is the most important parameter to establish groundwater is shallow [15]. Tehran within the environmental and human impact of local conditions vary according to the groundwater level (Which is read by over 27,000 from more than 170 wells in the area from 1996 until 2011 in South Branch, South and South-East Tehran (Varamin area) in different seasons), after collecting data in Excel to summarize and evaluate the change trend of water levels in Tehran upon investigation it was found in March of each year, Tehran has a higher level of ground water wells that information Piz metric was cited May 2011 Tehran and Suburbs. The geographic coordinates as well as seeker, do reading another layer into the GIS software's Map (Fig.3) Pizo metric borehole location was added to the other layers. The depth of each borehole water level relative to the opening balance was attributed to speculation. Due to the topography and geological map and check the water level contours elevation. To draw a line in the water level in GIS raster maps (Raster) are required. Raster map is a map where the surface area of each borehole, a single color (pixel) becomes clear is that each color represents a depth which can be identified by the software. Following is a brief description of the method and how to create maps.



**Fig 3 -** Map of ground water level and borehole location in the study area.

## 6-Conclusions

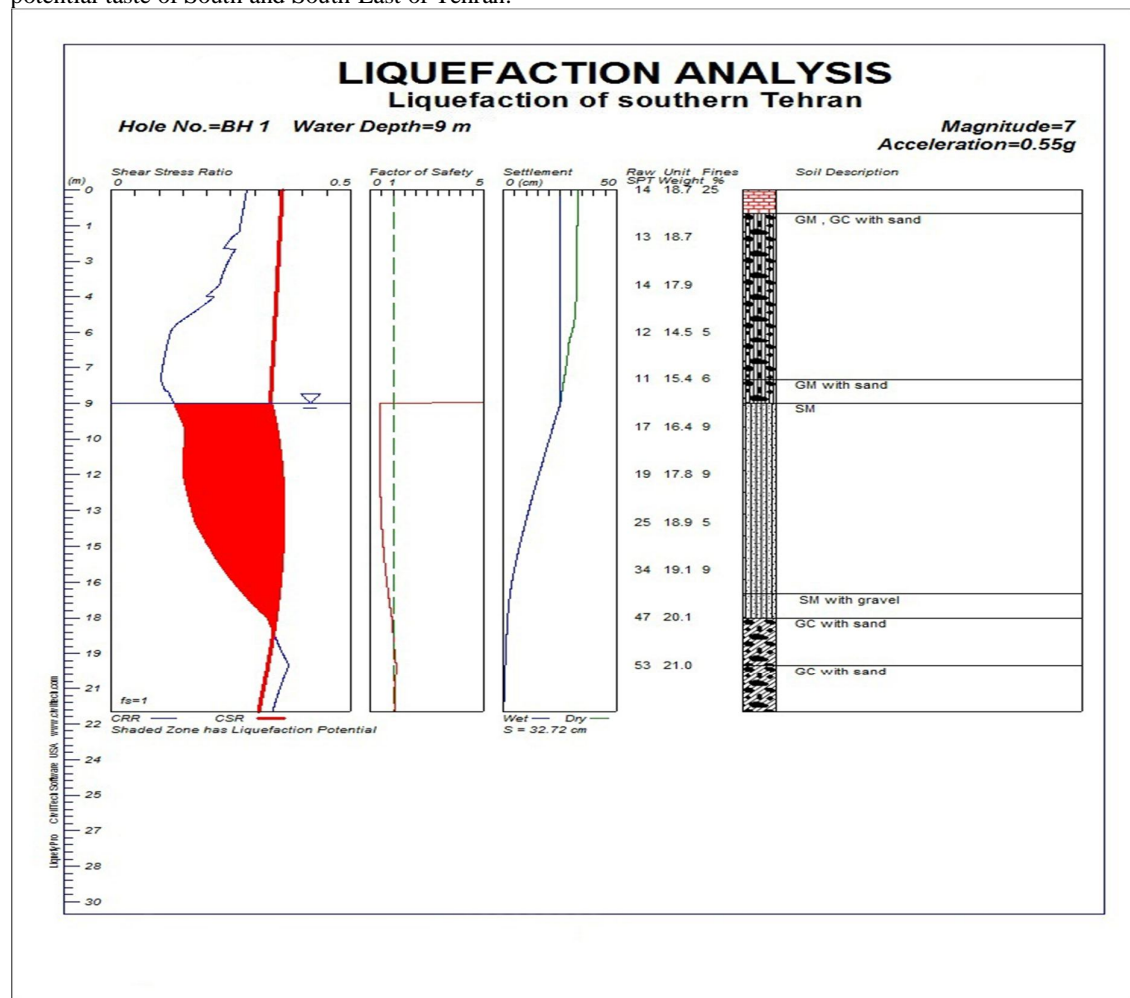
The creation of the Geotechnical Database Management crisis in Tehran in recent years based on information collected from various sources in Tehran Geotechnical testing and data collection and numerous



urban projects can be considered accurate calculations on individual borehole liquefaction potential [10]. In these research efforts is that zoning should be based on accurate information and accurately determine the boundaries of this area that is away from the borehole and accurate information that is available on not in terms of zoning. One advantage of this study compared to previous research conducted by others in the range, accuracy is the zoning liquefaction.

The results of this study can be expressed as follows:

- 1- The metropolis of Tehran lowest water levels in the central and southern areas of the city (in the range district 3, 6, 7, 11, 12, 15, 16, 17, 19 and 20) is located.
- 2- Earthquakes in the study area in different regions vary according to the type of fault. Earthquake 475 year return period with a magnitude of between 7 and 9 and return to PGA at different locations within the same period is 0.4 g to 0.6 g.
- 3-Tehran has a variety of sedimentary deposits on the basis of which it cannot fit in a certain context of Units but generally classified on the unified further north Tehran coarse sand in the more central area of the southern area is more fine-grained.
- 4-According to the analysis carried out in different software liquefaction potential within the central, southern, and south-east Tehran. Small areas in north Tehran to disperse, but there is also much potential for liquefaction potential taste of South and South-East of Tehran.



**Fig 4**-diagram of liquefaction analysis:

## 7-Acknowledgments

Thereby preventing the crisis management organization and of Tehran for providing drilling data Ricochet grateful geotactic.

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