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Engineering Geological Mapping At East of Isfahan City Using GIS

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Abstract: Quaternary deposits which cover about a half of country area are counted suitable places for building, water security and agriculture. In spite of studying different characteristics of these deposits, the recognition dispute of engineering geological characteristics of these deposits has not found its position yet. To show the distribution and local relationship of different investigated characteristics such as surface and subsurface soil and soil texture and compaction in the area and geotechnical parameters analysis, it has been used to prepare an initial map including geological maps and liquefaction susceptibility zoning map, and at last with summation of investigated characteristics, it has been made an applied engineering geological map for the East of Isfahan. This is a multipurpose, complete and medium – scale map, in which it has been brought the parameters such as subsurface stratigraphy, groundwater depth, liquefaction susceptibility, inflation potential, spread of fill soil, confronting depth to sand layers and a lot of another parameters. The final result of this research is more recognition of engineering geological of Isfahan area, to identify engineering geological hazards and giving the ways to solve these problems.

Key words: Engineering geological characteristics, Engineering geological map, GIS.

INTRODUCTION

The first steps cooperation between geologists and engineers in order to prepare engineering geological map of large buildings for example tunnels, dams and tracks was started.

An engineering geological map can reflect not only history of engineering geological conditions but also dynamic appearing and expanding of these condition by showing distribution and local relationship of these basic elements of engineering geological conditions. When distribution and local relation are showed by helping of this map one can predict the around effect on engineering structures and also can predict how disorder of these structures will be around. These maps have a key position and are too important in the engineering geological information system. It's obvious that maps can not be replaced by detailed study construction of a structure, but will help logical planning of studying construction and interpretation of study results.

In fact, in the engineering geological maps and environmental maps providing of engineer's needs to build structures and further more environmental conditions and future environmental consequences have also been considered that they are very important in the major programs and even large scale.

Preparing engineering geological map at east of Isfahan city has been done in two main parts. In the first part, features of engineering geological deposits have been studied. In this section, public and private conditions and also development and horizontal and vertical distribution sedimentary units have been evaluated by using the results of drilling core and laboratory and field tests obtained from various reports of a development projects of city and field studied.

In order to determining and introducing engineering geological features and general conditions of sediment of studied area, the information of area including maps and general geological reports aerial photos and digital satellite images are used.

The second part of studies is dedicated to study potential and major engineering geological and geotechnical risks. Major geological risks in Isfahan city includes:

Soil liquefaction, soil corrosive, being problematic soils, Potential of occurrence slope instability and landslides, settlement.

In field studies and investigating results of geotechnical tests of the area, evidence of the risks mentioned above were studied and with due to available information, prone area of each of these risks have been identified and in the engineering geological map are displayed.

Credit results of this study are reliable around 1:50000 scale with regard to scale of studies and geotechnical information at east of Isfahan and is used for development planning of Isfahan city and for initial valuations of engineering geological properties of deposits in different areas of Isfahan city. Obviously, geotechnical properties and identified risks in this map can be considered in stage of design and implementation of various

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structures within Isfahan city. In presented final map areas with high sensitivity and areas with less engineering geological problems have been mentioned.

Mention worthy that geographic information system has been used (GIS) for the preparation, analysis of different data processing and also used for improving the quality and accuracy of basic map and final map. Detail description is presented in continue.

Location Of Study Area:

Range studied in this research urban sector in traffic third ring east of Isfahan is located in a range of east longitude with coordinates 30 º 49 to 50 55 ºand North latitude 26 31º to 30 44º. Based ellipse WGS84 and geographic coordinate system UTM the area placed a piece of 39N . Isfahan, with an area of 106179/ 5 square kilometers is located in central plateau and coordinates is located between 30 and 49 º and 50 and 55 º eastern longitude and 26 and 31 º to 30 and 44 º in northern latitude. (Figure 1.)

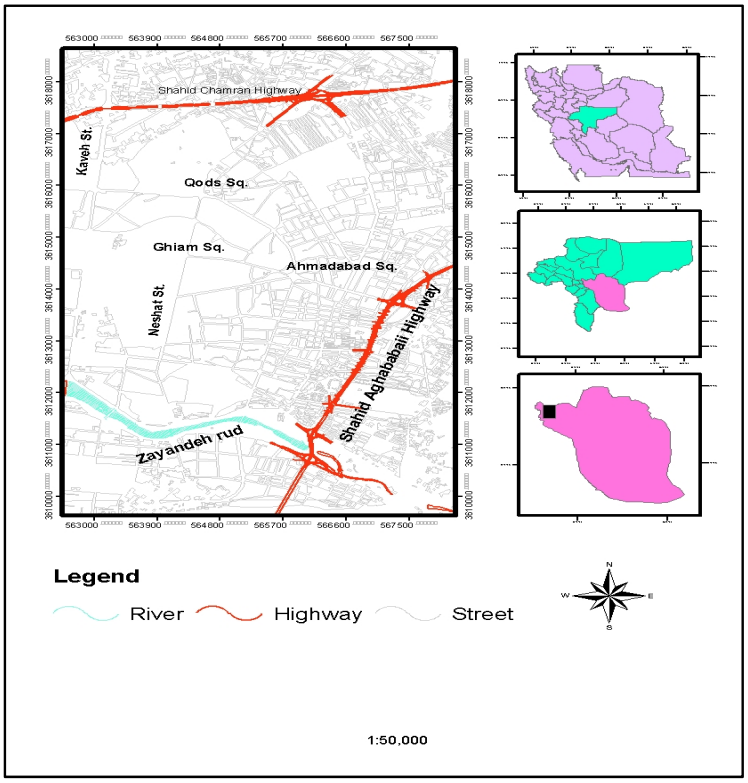

Fig. 1: General location of study area.

Geology Of The Study Area:

Stratigraphy of Isfahan city is as follows on the basis studies of urban train project.

Deposits of Jurassic:

Jurassic deposits composed of shale and sandstone layers with inter bedded of radiolarits, limestone and volcanic materials that outcrops in the south of Isfahan. Gradually this formation goes down under the river alluvial deposits and spreads to the north and gradually the thickness alluvial is added.

Calcareous formation of Cretaceous:

These formations are expanding in the Southern Isfahan city and formed of relatively resistant to non resistant limestone that the major geotechnical problem about them is existence of various discontinuity such as stratification, faults, the joint and gaps in the rock mass.

Deposits of Quaternary:

Quaternary deposits in Isfahan city are formed of two major parts alluvial fan deposits or foothills sediments and Zayandehrud deposits. Alluvial fan deposits are the result of elevation erosion of south Isfahan. They cover Jurassic rocky deposits in the city southern. Thickness of these deposits is low and interfingering

and are replaced by Zayandehrud sediments interfingering north. These deposits formed of sand corner, rubbles filling silt and clay. Lenses of sediments of clay, silt with sand have been seen between the lines.

Zayandehrud deposits are the result of sedimentation of Zayandehrud river during the rebellion and peace period. Sub surface stratigraphy of Isfahan city is made up of rebellion sediments and torrential plain. Rebellion deposits of Zayandehrud are made up of sand with low semi-worn gravel as worn with well to bad graded. This graiding includes poorly amount of microlithics components. In between these deposits lenses of tiny sand, silt and clay are observed. Phenomenon of Interest about these deposits is local sticky with carbonate sediments. This local sticky causes a kind of semi-hard to hard deposit in the form of lenses. Floodplain deposits have formed of silt and clay with low to high plasticity with a little sand and gravel.

It's considerable that fill soil with thickness of 4 to 5 meters is on the Zayandehrud deposits in central city of Isfahan that is formed of fine soil with coarse components and rubble. Lithology of sediment are fine in the northern parts and southern part of the studied area. And in low depth (about 8 m) by increasing depth sediment is coarse such as sand and gravel. Boundary between fine soils and coarse soils is not clear. Coarse soils are seen locally at depths of less than 8 meters in the northern parts of Zayandehrud. Therefore that is not expected that fine sediments converted to interfingers coarse sediment.

Description Of Base Maps:

Topography map and zoning of concordance, current landuse map of Isfahan city, geological map of Isfahan and other map show conditions of groundwater, and results of seismic analyzes of Isfahan are used in prepared applications maps. Due to geotechnical data of studied area includes140 bore hole and testing of various field and their laboratories. Different applications are provided as follows:

1. Map of Location existing and drilling borehole at east of Isfahan city.
2. Map of soil moisture in different depths (1 to 5 meters).
3. Map of spreading deposits in different depths (1 to 11 m) (Fig. 2).
4. Map of prediction the depth of approach to sand layers or sand lenses (drilling depth to 12 m) (Fig. 3).
5. Map of thickness of sand layers or sand lenses (drilling depth to 12 m) (Fig. 4).
6. Zoning map of soil resistance at different depths at east of Isfahan city (Fig. 5).
7. Map of problematic soil at different depths in the east of Isfahan (1 to 8 meters) (Fig. 6).
8. Engineering geological map of the east of Isfahan city (Fig. 7).

About applications maps the following noteworthy cases are considered:

- Situation of 140 drilling borehole have been shown in Isfahan city.
- Moisture soil maps (1 to 6 meters) have been displayed in the shape of a point.
- The Map of spreading deposits in different depths (2 to 5 m) is one of the most practical maps of Isfahan that it to shows expanding the types of deposits at different depths in the region as well.
- By using the prediction map of depth of treat to sand lenses or sand layers one can gain (drilling depth 12 m) an estimate of the probable depth treated to sand layers that is important in construction of various structures.
- Map of thickness of sand lenses or sand layers (drilling depth 12 m) can define layer or lenses of sand in specified areas in the previous paragraph.
- One of the important application maps is map of excavation potential that to classification. Sticky and non sticky deposits at east of Isfahan city from point of view resistance. This map can provide estimation from excavation potential in Isfahan city. Criteria's of zoning soil resistance are mentioned according to tables 1:

Table 1: Evaluation density and hardness of soil based on the Modified Standard Penetration number.

Group	cohesive soil hardness	Soil density non cohesive	sticky soils N-value	Non-sticky soils N-value
A	Very soft	Very weak	0-4	0-4
B	soft	Weak	4-8	4-10
C	Medium	Medium	8-15	10-30
D	Firm	Dense	15-30	30-50
E	Hardware	Very dense	>30	>50

- In the map of zoning of problematic soil 3 parameters are displayed:

1 - Spreading of filling soils from the surface to a depth 8 meters.
2 - Potential of swelling to depth 8 meters.
3- Ability of soil liquefaction from the surface to a depth 8 meters.

- Engineering geological map at east of Isfahan city that is the result of combined all the necessary information of applications maps.

Description Of Engineering Geological Map:

The results of studying engineering geological and preparation of applications maps at east of Isfahan city were presented. For improving products of these findings, the final engineering geological map has been prepared. The information of this map is mentioned as follows (Fig. 7):

1. Point changes of moisture percentage of soil (depths 1 to 6 meters)
2. Point changes of internal friction angle of soil (depths1 to 8 meters)
3. Point changes of soil sticky (depths1 to 8 meters)
4. Point changes of soil wet density (depths1 to 8 meters)
5. Point changes of conditions of soil corrosive in different depths, including chlorine percent, sulphat and PH (depths 1 to 8 meters).
6. Contour lines of underground water.
7. Zoning of soil excavation potential (from very easy to very difficult).
8. Zones having potential of liquefaction.
9. Depth range of contact to sand layers.
10. Potential of swelling (depths1 to 8 meters).
11. spreading of fill Soils (depths1 to 8 meters).
12. stratigraphy of subsurface (depths 0 to 2 m)

Following cases are mentioned for engineering geological map of Isfahan:

- In order to display Parameters in this map simultaneously, some of them are shown as points, some are linear and some of important parameters are zone.
- Zoning of excavation potential and zones having liquefaction capability and potential of swelling and fill soil are displayed with hatching and different colors.
- With due attention to parameters such as percent of soil moisture, angle of internal friction, sticky and wet density are shown with different signs, it has been tried to avoid preparing a busy map by presenting suitable distribution of data selected.
- With due attention to map preparing in the GIS, possibility study of engineering geological parameters in each arbitrary site, meanwhile can be shown output with different scales.
- The possibility and ease of adding layer or new information in map is capabilities preparing engineering geological map in GIS.

With due attention to basic maps one have can available specific applications maps for the area such as map of soil moisture at any depth (1 to 6 m), zoning of soil resistance map at any depth (1 to 8 m), zoning of liquefaction capability map at any depth (1 to 8 meters) and other application maps and output and information presented for each part of the region.

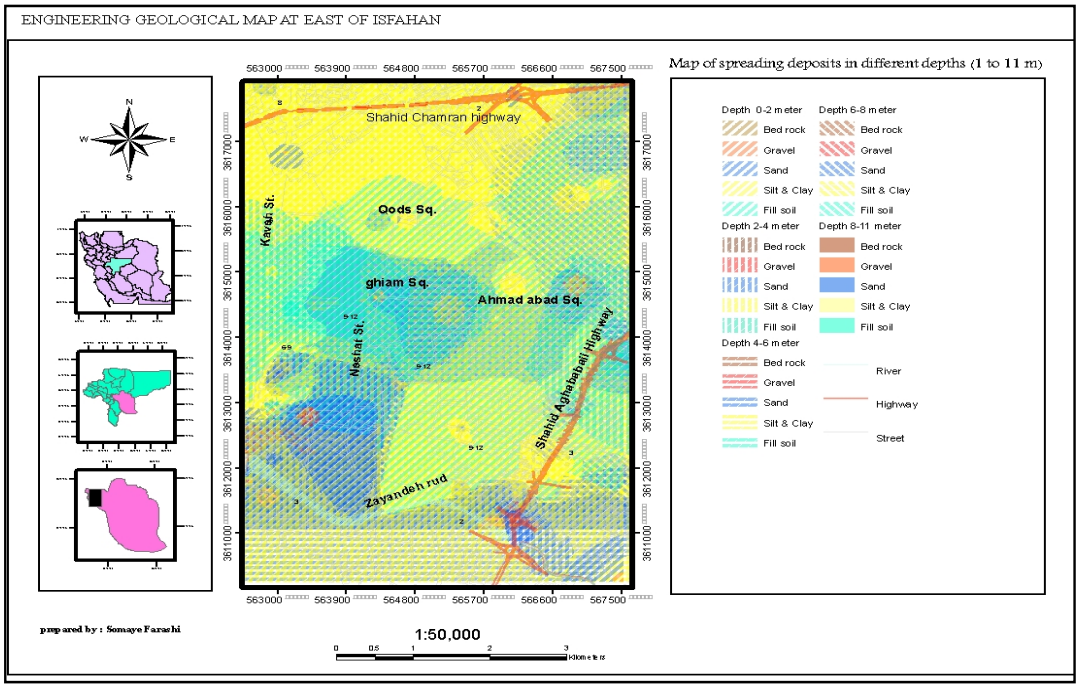

Fig. 2: map of spreading deposits in different depths (1 to 11 m).

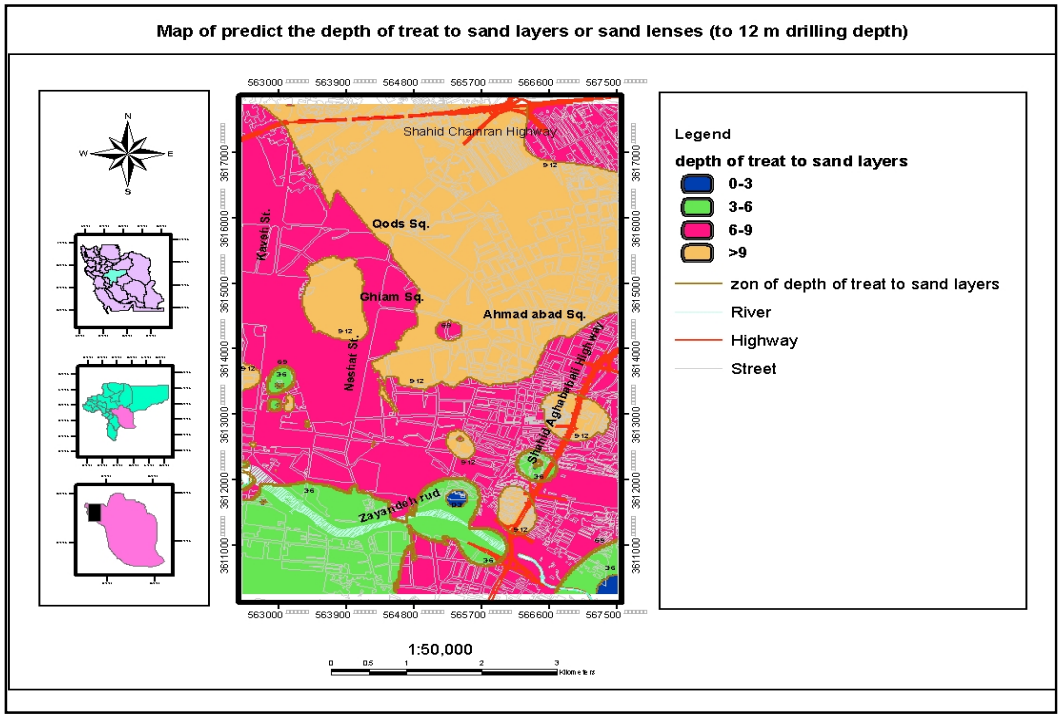

Fig. 3: Map of predict the depth of treat to sand layers or sand lenses (to 12 m drilling depth).

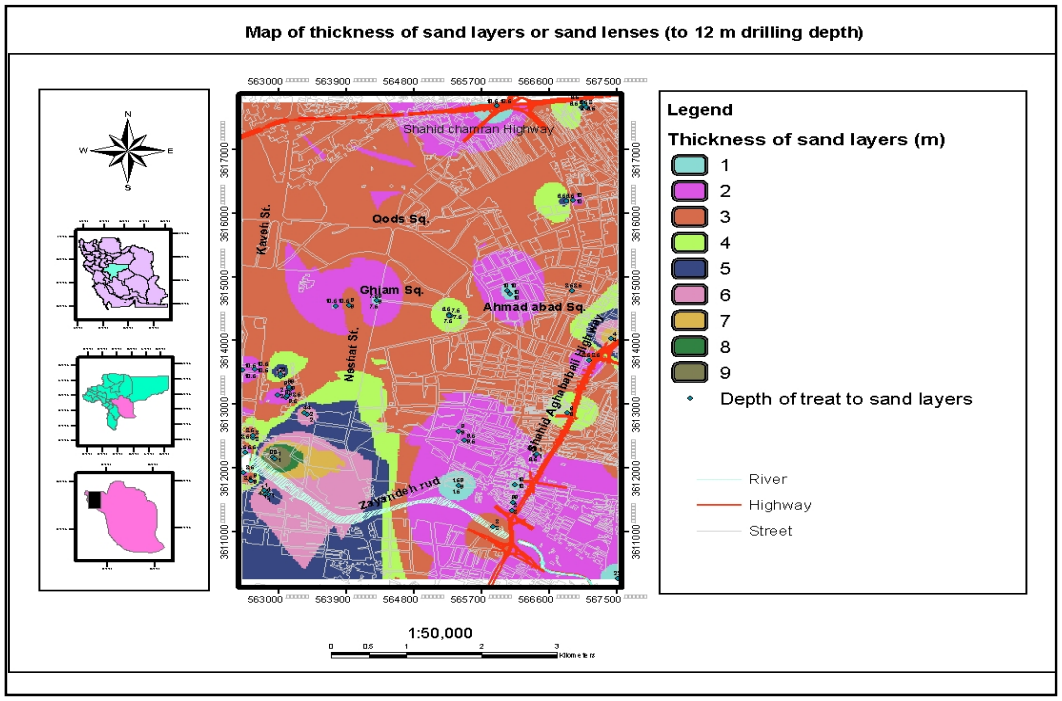

Fig. 4: Map of thickness of sand layers or sand lenses (to 12 m drilling depth).

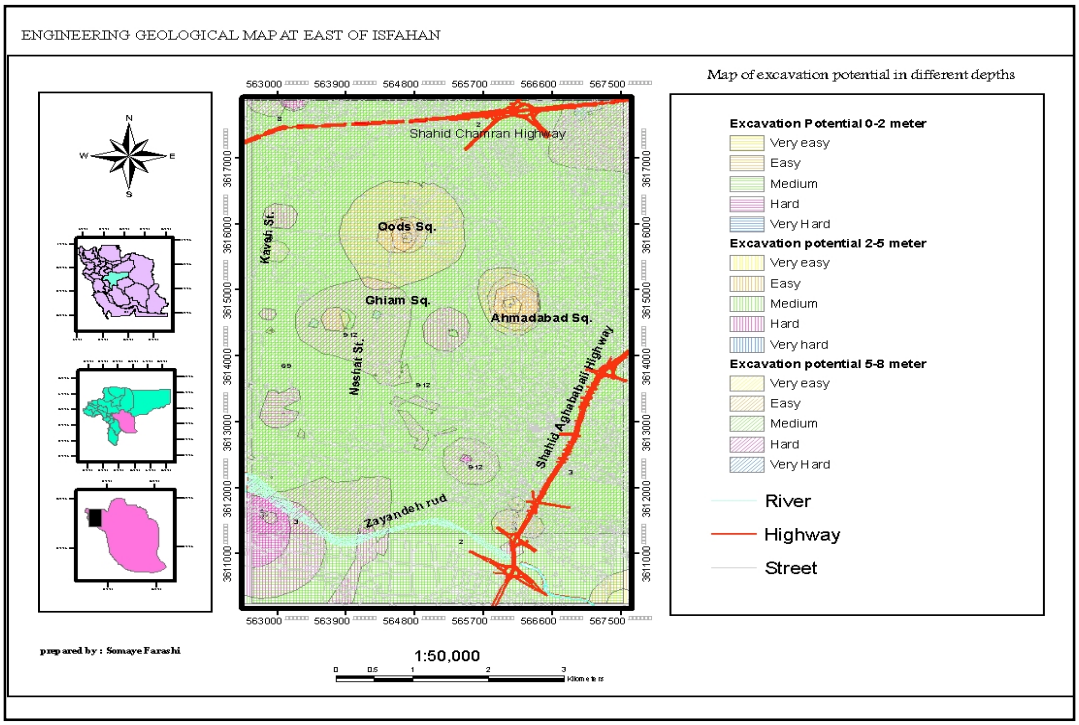

Fig. 5: zoning map of resistance of soil at east Isfahan city in different depths.

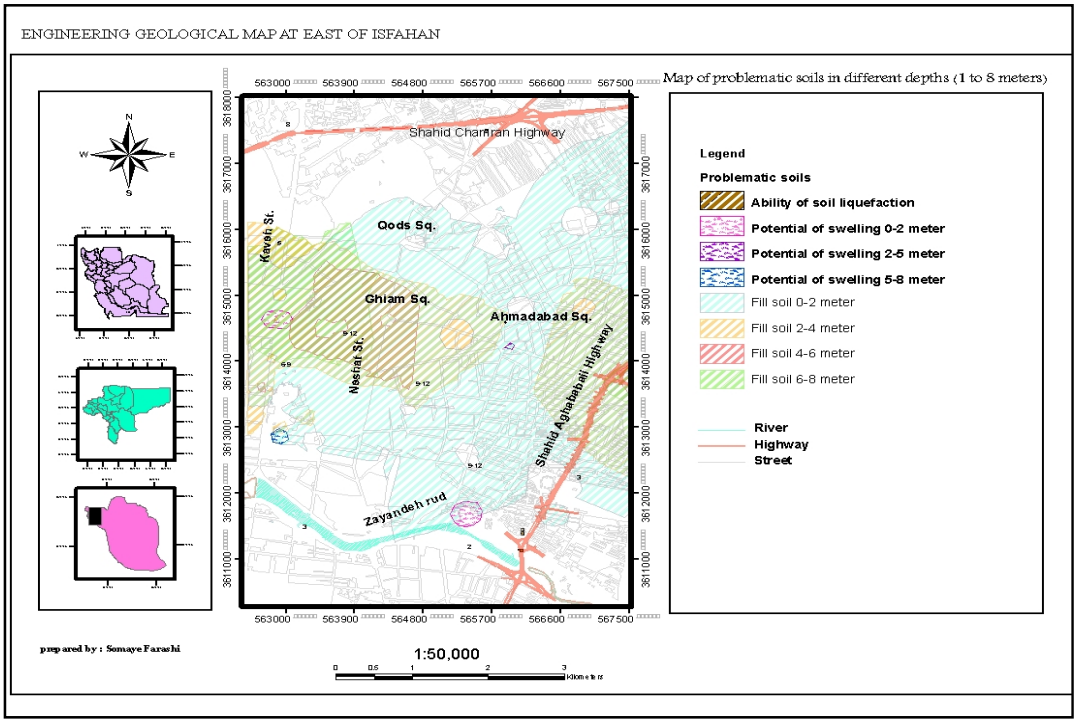

Fig. 6: map of problematic soils at east of Isfahan in different depths (1 to 8 meters).

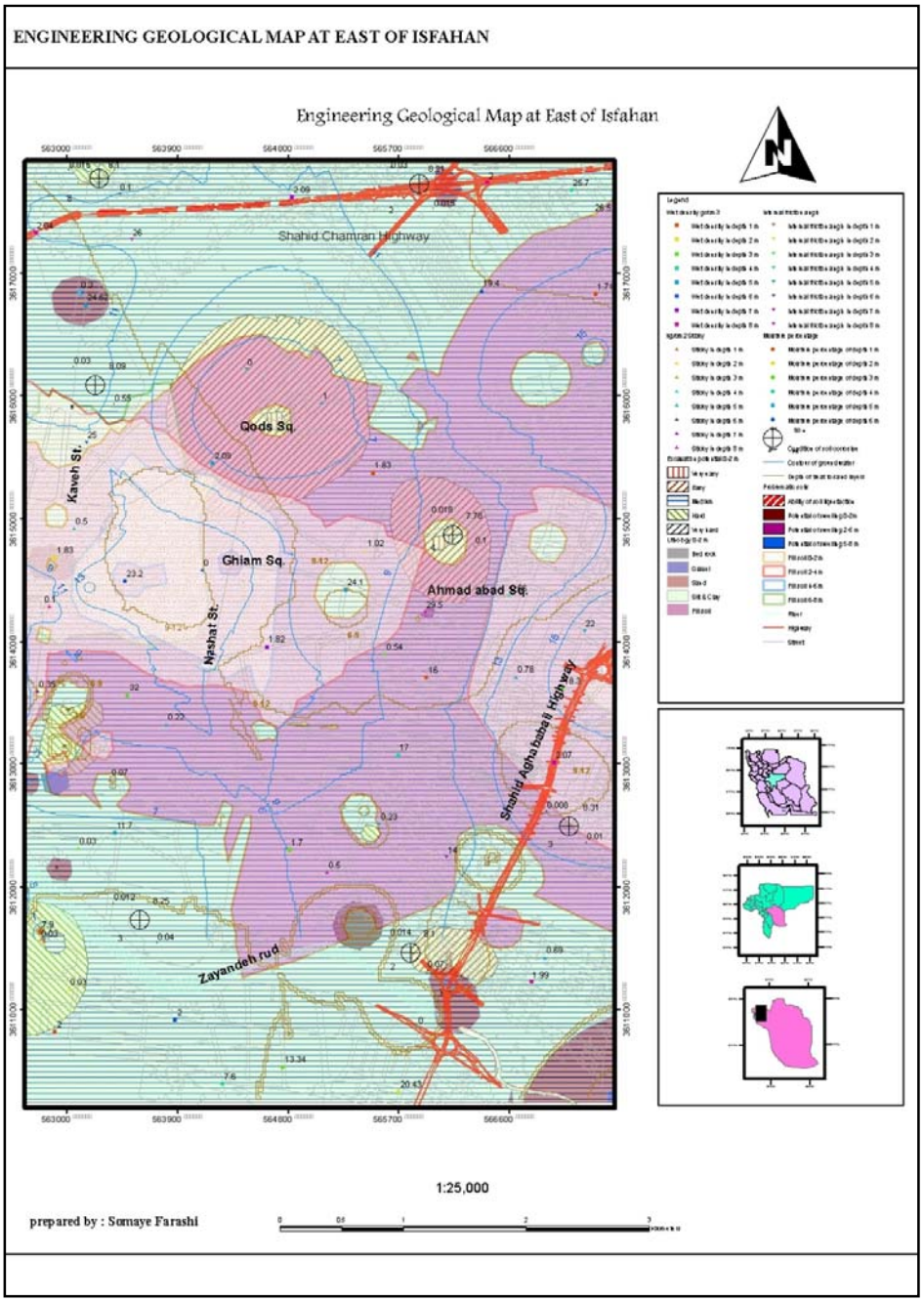

Fig. 7: Engineering geological map at east of Isfahan city.

Conclusion:

According to results and final hazard map, it is concluded that with increasing the depth, sediment becomes coarse. In fact the sand layers are with different thickness at different depth. The excavation ease in most places is medium and occasionally hard to the depth of 8 meter. Exceptionally in west south of studied area. Excavation potential is very hard. In the central part of the region, the main deposit consists of fill soils to a depth of 8 meter. After this depth, fill soil become less and changed to sand soils. In almost studied area, soils have not potential of liquefaction and swelling. Geotechnical engineering parameters such as internal friction angle, cohesion, water content, corrosion conditions, soil classification and etc. have been display in geotechnical map in different depths.

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