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Effects of Adjacent Building Construction: A Case Study

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ABSTRACT

Because of increase of population and urbanization, use of urban spaces for the construction or upgrading and retrofitting is inevitable. In such circumstances, in the constructing a new building imposes negative effect the operation of existing buildings and practically investment made on such performance will be useless. In addition, it may endanger human life. Therefore through a closer analysis of the characteristics of adjacent structures, can be prevented capital loss and human casualties. Currently, many judicial cases concerning losses which incurred due to construction of new buildings adjacent to existing buildings are available in the courts of law. However the limitations of regulations and preventive procedure rules are not efficient enough in this regard. In this paper, the negative effects of adjacent building construction in a case have been studied and various solutions are offered to reduce its adverse effects.

KEYWORDS: adjacent buildings, soil settlement, urban construction, Foundation

1. INTRODUCTION

Due to the economic development and population growth and the need to provide housing for various social groups, the remaining urban areas are used for construction. On the other hand, in order to optimize utilization of all urban spaces, new buildings are built in the form of tall buildings and this may be located nearby the buildings with low floors. In addition, the need to reconstruction based on national regulations on urban area is increasing every day, while foundation interaction is not often taken into account.

Constructing a new high-rise building, considerable stress is transferred through the earth. This is especially important "in areas where the soil is made of fine-grained. So, to designing such buildings, in addition to the soil properties which must be carefully evaluated, it is necessary to considered the status of adjacent structures.

2. The Adjacent Building Effects

The adjacent building effects that include the effects of constructing a new building adjacent to an existing structure, can be investigated in two sections:

2-1- Overground effects

Overground effects, which refer to the impact of two adjacent buildings over the ground surface, and usually occur after the construction of two adjacent buildings, are prevented based on the limitations imposed by various regulations, such as earthquake regulation. Therefore, the overground effects can be removed by respecting seismic separation joint in the interface of two structures. For example, according to Iranian Earthquake Regulations, a minimum seismic separation joint at each floor level is equal to one hundredth of its height level from base level.[1]

2-2- Underground effects

Underground effects can be divided into two sections.

2-2-1- The drift of soil under the existing building due to soil excavation

In Figure 1, the effects of soil excavation is shown. To construct a new foundation (if the height of excavation is more than buried foundation of adjacent building), it is necessary, using appropriate methods prevent soil lateral movement (sliding wall). In this regard, in urban construction, substantial rules are enacted to respect excavation effects in the vicinity of the buildings and it is controlled by the relevant authorities.

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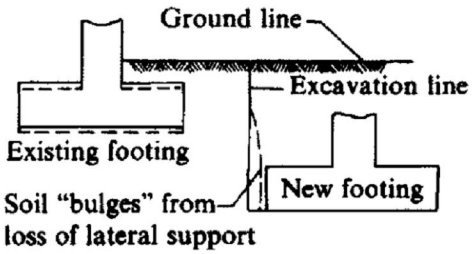

Figure 1. The Possible settlement for existing foundation due to the lack of suitable retaining wall [2]

2-2-2- The settlement of existing building due to added stress by the new building construction

An important factor in the settlement of adjacent building is that how the added stress spreads under the foundation, and how the interaction of stress bubbles occurs. As seen in Figure 2, stress caused by the foundation, is propagated both in the vertical and lateral direction[3]. So if the amount of stress propagation in the lateral direction affects the stress bubble of adjacent foundation, the region in which the stress bubbles resulting from two foundation interfaces, is placed under increasing stress, and as a result, consolidation settlement would be expected.

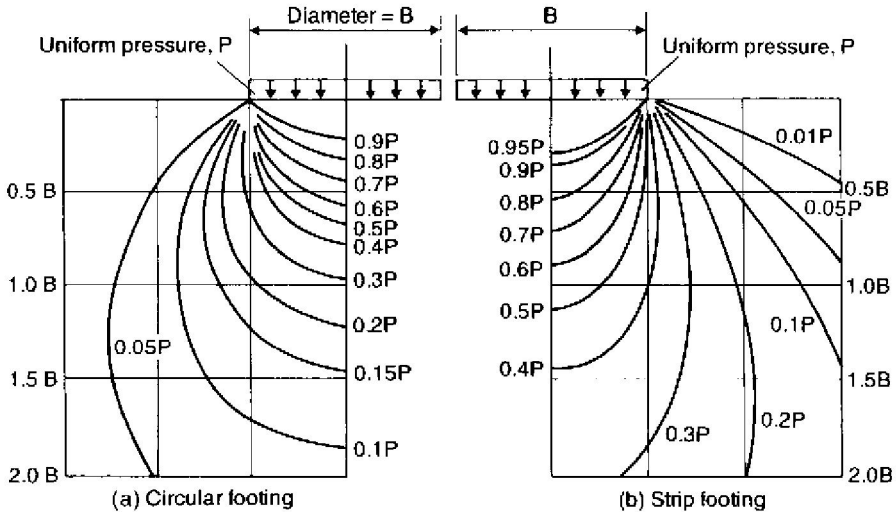

Figure 2. Pressure bubble for square and continuous footing [3]

Since in urban construction, new building construction occurs on one side of the existing structure, the settlement resulting from the increasing of stress due to construction of new building, is non-uniform. So, In defining the criteria for allowable differential settlement, the effect of adjacent buildings must be considered (Fig.3) where applicable. For this reason it is recommended to arrange at a zone, where the stress in underground changes suddenly and to a larger extent (e.g. one-story buildings near a high rise buildings)[4]. In a practical case, constructing of a new building which has adverse effects on the old building, is studied.

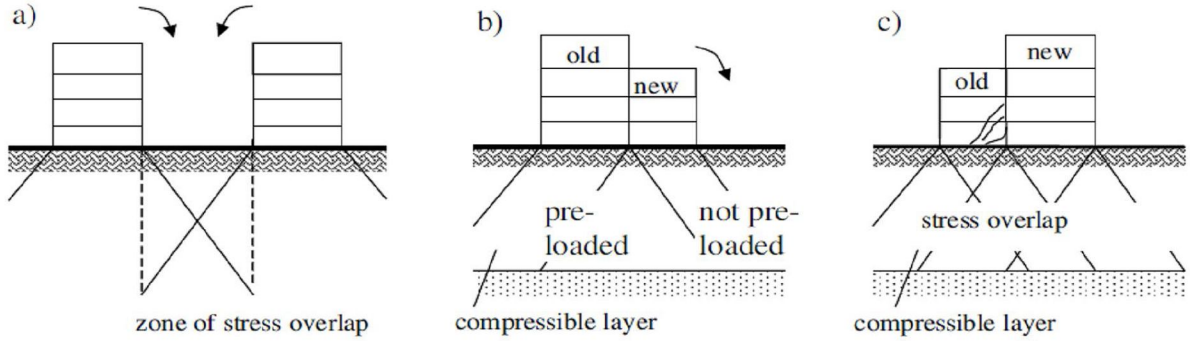

Figure 3. Interaction between adjacent buildings [4]

3. Case Study

In this section, a case in the north of Iran (Rasht – as the capital of Guilan) is presented. In 1998, a four-storey building (Called building No.1) is constructed with a brick facade and steel frame in a clay deposit. It occupies 210 square meters. Its foundation details are shown in figure 4.

To resist against lateral forces in this building, steel bracing system in two directions has been used. In addition, for bearing of forces and transferring them to the ground, strip foundation is used.

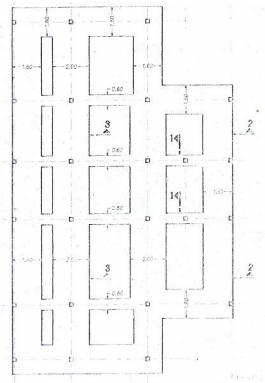

Figure 4. Foundation details of building No.1

In 2009, a six-storey building (Called building No.2) was constructed at the adjacent of the building No.1. This building has a stone façade, occupying 285 square meters and constructed with concrete frame. To resist against lateral forces, shear wall and concrete frame system have been used. Mat foundation is used for bearing and transferring forces to the ground. Details of the foundation of this building in figure 5 are presented.

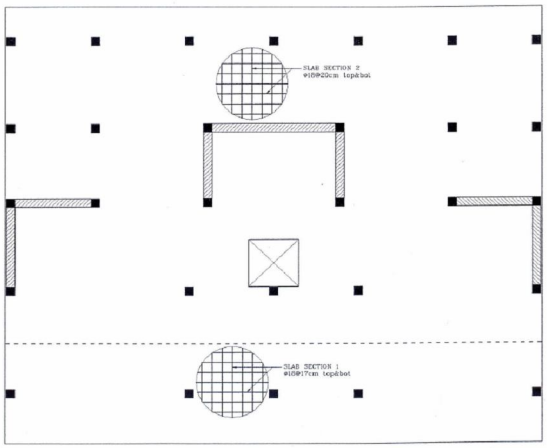

Figure 5. Foundation details of building No.2

Geotechnical investigation indicates that the soil under the foundation up to the depth of 12 meters includes clay deposit with low plasticity (CL). Groundwater level is located at the depth of one meter from the ground surface.

4. DISCUSSION

The case mentioned above, is one of the examples of the effects of the adjacent building. A four-storey building (building No.1) was built on clay layers, and after 11 years, a new six-storey building was constructed at vicinity of old building. Clay layers (at least to a depth of 12 meters based on the geotechnical report), cause considerable consolidation settlement.

According to the arrangement of the two structures (Figure 6), and transferring the added stress from new foundation to the soil under the old building, it was expected that the soil under the foundation settle within the interaction area. This settlement could give rise to problems in the operation of the old building.

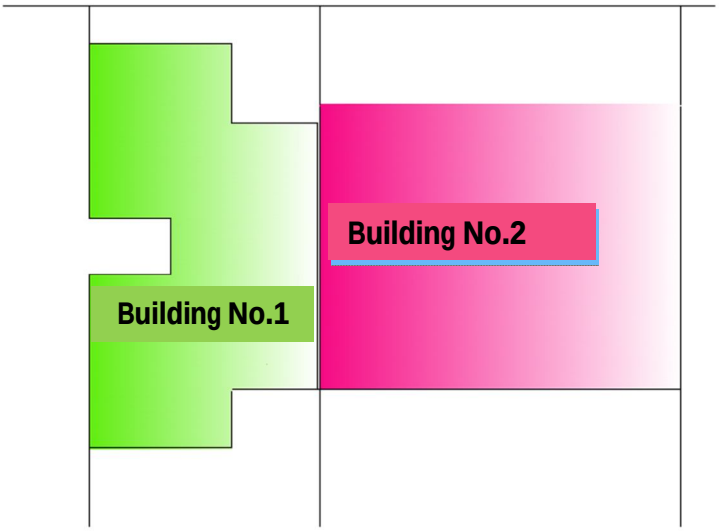

Figure 6. arrangement of the two adjacent buildings

After the construction of new building (after full loading), residents of the old buildings felt strange and suspicious noises at night. These sounds were amplified every day to the point that crake was seen in the walls of the different parts of the building. So the adverse effects of new building construction appeared.

Based on visits conducted in April 2011, the frontage wall of the building No.1 is separated from the western neighborhood building and the amount of deviation increased along increasing height, in which the maximum deviation from the vertical line at the highest point was about 80 mm.

The west beams had been deviated from the vertical line. The maximum deviation in the highest point of the structure (height 12 m) is reached up to 78 mm. The stone facade of the building in the northern parts had diagonal crack, whose width was up to 8 mm. Ceramic of third floor of East Unit had just been cracked. Diagonal cracks in the walls of the staircase and upper floor units had occurred. Ceramic of the ground floor of East unit had been cracked and been settle about one centimeter at a displacement of 1.2 meters of the wall. Garage floor tiles had been cracked in the Northeast and Southeast.

In figure 7, elevation of two adjacent buildings, and in figure 8, the cracks in different parts of the old building are shown.

Figure 7. Elevation of two adjacent buildings

Figure 8. cracks in different parts of the old building due to adjacent building construction

5. Conclusion

To construct of the adjacent buildings, the overground effects are usually considered with respect to seismic separation joint. In the underground category, the effects of drift of soil under the existing building can be minimized considering the principles of retaining wall design. However in some cases, fatal accidents due to the lack of proper implementation of these structures are occurred. But the effects of the settlement have been neglected. This neglect has resulted in many cases as mentioned in this article, and the operation of the old building (because of the effects of the adjacent building) will be faced with the problem.

Lack of attention to the effects of adjacent building constructing may also cause the loss of investments to be made, and also impose the psychological effects on the residents of the building and consequently on society. Much time and money spent in the courts of law for review of such cases. Therefore, it is essential, in the designing process of new building, using effective methods to prevent adverse effects on adjacent buildings.

For example, for the case presented in this paper, the effects of new building construction on old building can be removed or reduced with the following methods:

- Placing the foundation of building No. 2 in a higher depth
- Improving soil under foundations with appropriate procedures
- Using pile foundation or micropile foundation
- Transferring the lateral load bearing system to the center parts of foundation from interaction area

In any case, wherever the effects resulting from new construction are expected, it is necessary to be use appropriate tools to control the condition in the old building, in order to resolve the problem quickly. For example, in the case mentioned this paper, if soil stabilization in the initial steps were carried out, the building further settlement would be prevented.

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