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Potential damage to residential building due to adjacent surcharge fill loading-case studies in Surabaya, Indonesia

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Potential damage to residential building due to adjacent surcharge fill loading-case studies in Surabaya, Indonesia

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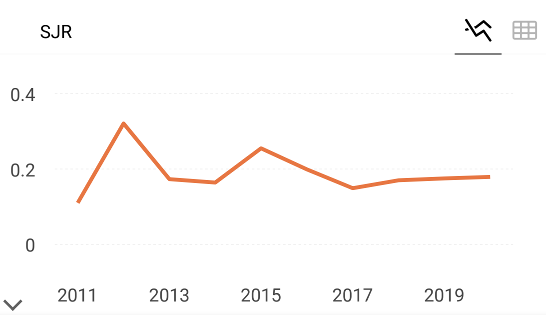

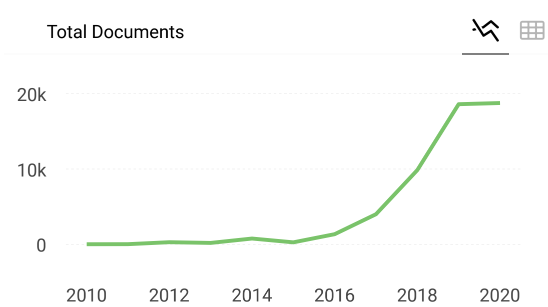

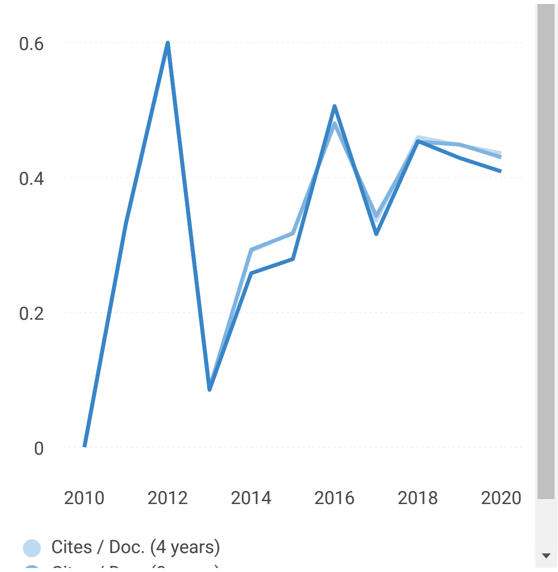

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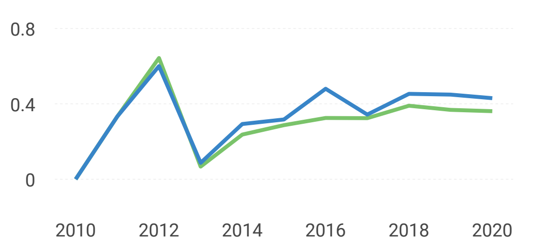

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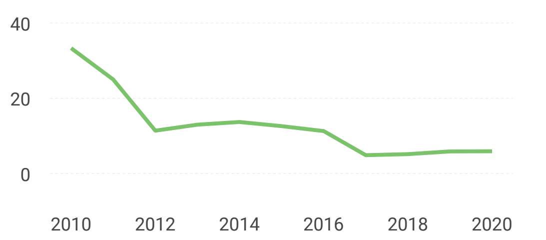

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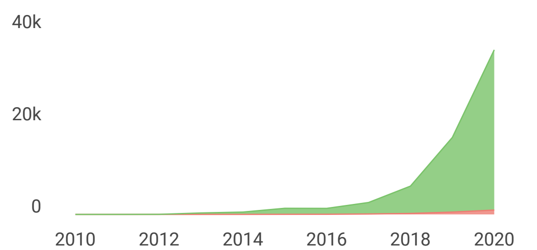

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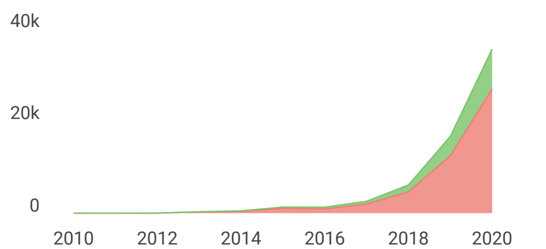

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Potential damage to residential building due to adjacent surcharge fill loading-case studies in Surabaya, Indonesia

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Abstract. Housing construction is a common construction activity and is always needed from time to time. House construction can be in the form of building new house or renovating an existing building. The impact of construction work to adjacent building or structure is something that cannot be avoided but must be minimized. The case study in this research aims to increase the awareness of all parties in construction project related to the potential damage to the surrounding buildings that may occur. This research was conducted with a case study on the construction of residential houses in Case A and Case B located in Surabaya-Indonesia. Field observations, analysis of damage causes, rectification methods and estimated cost were carried out in this study. These two case studies presented the damages analysis on residential house due to settlement which caused by adjacent surcharge fill loading. This settlement causes a differential settlement on both sides of the existing building, which had impacts on floor slope and cracks in wall. Proposed rectification works were made to restore the house to reach minimum serviceability requirement and prevent further damage in the future. The cost of repairing and retrofitting the damage existing house significantly increases the budget for a new house construction project. Therefore, careful planning in construction project considering the impact of soil settlement is needed more attention, especially in a dense urban area. Good communication and coordination between contractors and owners of neighbouring building are also needed to minimize the potential conflicts during or after construction works.

1. Introduction

Surabaya is the second largest city in Indonesia with a population of around three million in 2020. The increase in population from year to year leads to the increasing demands for housing. There are several ways to fulfill housing demand, especially in urban areas, building a new house, demolishing an old house and rebuild the new one, or renovating an old house.

In general, housing construction projects in a densely urban area will have some impacts on its surroundings, especially neighboring buildings. Noise, dust, and damage to nearby buildings are sometimes unavoidable due to the construction project. The damage to nearby buildings often causes prolonged disputes because this may cause a significant increase in costs and delays in a project [1, 3]. Construction activities such as demolition, additional loads, vibrations, excavation, and dewatering, might potentially damage neighboring buildings. The common of damage are in the form of cracks in the walls and uneven floor of adjacent buildings [2, 4, 5, 6].

If the damage incurred to adjacent buildings, it is the responsibility of the contractor to carry out a condition survey to assess how the construction works affected. It is necessary to conduct damage assessments by doing visual observations of damage, to find out causes of damage, types of damage,

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and how dealing with damage, including how much it will cost to repair the damage to the adjacent buildings. This paper presents a case study of residential houses damaged by adjacent surcharge fill load. This study aims to describe the adjacent building damage assessment and increase awareness among all parties in construction project, both owners of new and existing residential houses, designer and contractors.

2. Research procedures

2.1. Observation of damage

This study was started by doing visual observations of damage on observed building. These visual observations are accompanied by measurement, recording, and documentation the incurred damage. Table 1 shows simple check list of damage on observed building.

Table 1. Damages check list of location observation.

Number	Damage Items	Volume	Unit	Note
1	Cracks	….	m’	…..
2	Floor settlement	….	m^2	….
3	Door settlement	….	Unit	….
4	Ceiling levelling	….	m^2	….
5	Etc.	….	….	….

2.2. Damage analysis for observed buildings

The first step in the damage analysis process was visual observation on observed buildings, which was to identify the possible causes of damages. Further steps of damage analysis were doing data collection by surveys and interviews with all parties, owner and contractor of construction work and owner of adjacent buildings. All of data collected was from pre-construction to post-construction phases of construction works, including demolishing an old house, building new house foundations, construction of surcharge fill loading, and building upper structure of new house.

2.3. Rectification suggestion and cost estimation

Rectification woks were planned based on damage analysis results, including repair and retrofitting the damaged building. Rectification was conducted regarding as serviceability issues, for examples repairs works of cracks in wall, distorted door and window, and uneven floors. Rectification work was also conducted regarding as stability issues, such as underpinning works. Based on the appropriate rectification works, works cost were estimated.

3. The case studies

Two cases of damaged building due to adjacent construction work were selected in this study. Both cases are one story residential houses located in Surabaya City, Indonesia.

3.1. Evaluation of residential house as Case A

The damaged house as Case A, as an existing building, is located on the right side of the new building construction work. This project was doing construction a new house building with surcharge fill of 1 meter in height. From visual observation, it was found that there were some cracks in the walls in several rooms. A sizable crack was found in exterior walls of the Case A house as shown in Figure 1 (a). From the crack pattern, it was an indication that the left side of the existing building has settled. In addition, cracks were also appeared in wall in a room, as shown in Figure 1 (b), which is located on the left side of the Case A house.

(a) (b)

Figure 1. Diagonal crack on wall.

There were some obvious signs of differential settlements, including cracks in the floors and doors are hard to open and close. The cracks in floors were clearly visible in the living room area as shown in Figure 2. From the form of cracks in the ceramic floor, it shows that differential settlement occurred in between the left and right sides of the Case A house. The differential settlement was recorded at 7 cm with water level measurement.

Figure 2. Settlement on living room.

3.2. Evaluation of residential house as Case B

The damaged house as Case B, as an existing building, is located on the left side of the new building construction work. It was measured as 1.3 meters of ground elevation differences between two adjacent buildings. It was due to the new building was built on surcharge fill with height of 1.3 m. As a result of the additional load on the right side of the building, there is a greater amount of settlement on this side compared to the left side of the building. Diagonal cracks on wall also indicated a differential settlement in building. These cracks occurred on the exterior walls, the walls in the living room of the Case B house (Figure 3).

Due to the additional load of surcharge fill, there was a settlement on the right side of the existing building which caused a slope on the floor. The difference floor elevation between the left side and the right side of the Case B house was about 8-10 cm by water level measurement. It is shown between point A and B in Figure 4. Differential settlement also resulted damage to garage doors and some room doors. The doors were hard to open and close. Pictures of damages due to differential settlement is shown in Figure 4.

Figure 3. Diagonal crack on wall.

Figure 4. Diffrential settlement.

3.3. Settlement analysis

From evaluation on the observation location, the damage has occurred on residential houses due to adjacent construction works. The differential settlement and cracks were mainly caused by the settlement of the houses due to adjacent surcharge fill loading works.

Basically, any additional load on a soil layer, especially clay soil, causes soil settlement. Total settlement of soil is total of immediate settlement, primary consolidation settlement, and secondary consolidation settlement. Immediate settlement occurs at the short time, immediately after additional load is given. Primary consolidation settlements takes place over long period of time, resulting from the discharge of water from the soil pore, and continued with a settlement in secondary consolidation [7]. The common causes of soil settlement are increasing loads due to surcharge fill load/ embankment, construction of foundation loads, and additional loads due to lowering of the ground water level.

Consequently, settlement in the soil layer will cause downward movement of the existing structure above the soil layer. If the settlement in the soil layer is uniformly distributed, the entire structure built over it will settle evenly. In terms of structure, this is not dangerous because it will only reduce the level (elevation) of the structure but will not cause a change in stress in the structure itself. If the settlement of the soil layer is not uniformly distributed (differential settlement), the structure built over this soil layer will experience a change in stress (internal forces will change) which can result in cracking of the building structure above it.

Regarding number of damages that occurred in Case A and Case B houses, the main causes of wall cracks and floor slopes were due to differences in settlement in the house, which is uneven settling between a side and the opposite side of building. Figure 5 shows the pattern of settlement due to adjacent surcharge fill loading works. In clay soils, the largest settlement will occur under the fill. Based on the settlement scheme in Figure 5, it can be explained that the settlement of the soil layer near the brick wall is greater than the settlement that occurs at a location farther from the brick wall in existing residential house. This will result in differential settlement of existing buildings in that location. The differential settlement in buildings of the observed houses in this study was recorded about 7-10 cm.

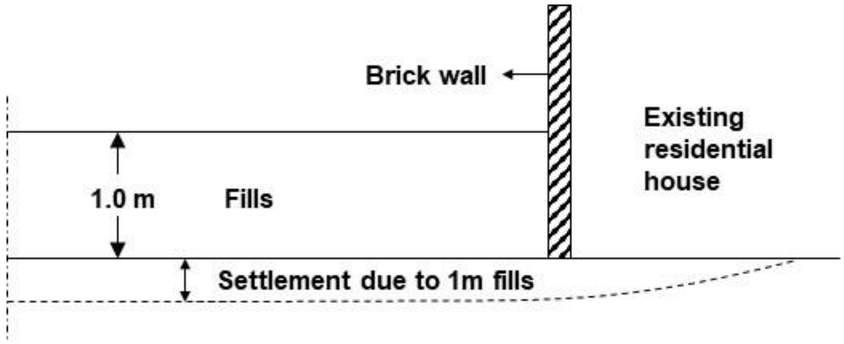

Figure 5. Prediction settlement due to fill.

To provide an illustration of the settlement in soil clay layer that occurs due to the addition of 1 m of surcharge fill load, a calculation of the amount of consolidation settlement is carried out based on Equation 1. The calculation is based on several assumptions of general clay layer and surcharge fill parameters as follows:

- Soil density, γ = 1.6 ton/m^3
- Initial void ratio (before surcharge load), e_o = 1.8
- Thickness of the compressible soil layer, H = 2 m (2 x thickness of surcharge fill)
- Compression index, C_c = 0.4
- Density of surcharge fill, γ = 2 ton/m^3

The settlement is only analyzed based on the formulation of primary consolidation settlement which is caused only by the surcharge fill load (excluding the upper structure load), Δp, with a thickness of 1 m. The settlement (ΔH):

$$\Delta H = \frac{C_c}{1+e_o} H \log \frac{P_o' + \Delta p}{P_o'} \qquad (1)$$

P_o' = 1.6 ton/m^3 x 1 m (overburden pressure at a depth of 1 m from the soil surface)
= 1.6 ton/m^2
Δp = 1 m x 2 ton/m^3 = 2 ton/m^2
ΔH = 0.10 m = 10 cm

Thus, it can be concluded that the estimated consolidation settlement is 10 cm due to the addition load of 1-meter-high surcharge fill load. The impact of this settlement will cause land subsidence around the building boundary. The settlement prediction using this calculation is matched with the differential settlement that occurs in the observed house. The differential settlement was measured between the left and right sides of the observed residential house, which located adjacent surcharge fill loading construction.

3.4. Rectification and cost estimation

In principles, the decision of the necessary rectification works was carried out to ensure the safety and continued serviceability of the building, in order to set the damaged building could have minimum serviceability requirement condition.

Based on the damage analysis, for both cases damaged houses in this study, it was found that houses damages were potentially induced by adjacent surcharge fill loading work. For both cases (Case A and Case B houses damage), it was analyzed that foundation retrofitting was required to strengthen the existing building foundation. Retrofitting was carried out prior to repair works, in order to terminate continued settlements of the building and to prevent cracks in building. Further settlement may develop more than a year caused by consolidation, especially in clay layer deposit, which may take several years to complete the consolidation. The proposed retrofitting method in these cases study was in the form of underpinning by a strauss pile foundation. Pile was designed with a diameter of 30 cm within a depth of

6 meters located at several points where settlement occurred. After retrofitting works, following repair works were conducted; floor leveling with sufficient compaction, ceiling leveling, repair of cracks in the walls, repair of doors and painting of walls. The cost of repairs and retrofitting for an existing house in Case A was IDR 153.94 million (IDR 1.97 million /m^2) and for a house in Case B was IDR 334.3 million (IDR 2.37 million /m^2). From this study, it was shown that total cost of repair and retrofitting works reached 50% of the total cost of building a new house, which is around IDR 4 million /m^2.

4. Conclusions and recommendations

This case studies assessed residential houses damaged by adjacent surcharge fill load. Based on damage assessments carried out on residential houses in Case A and Case B, the following conclusions and recommendations can be drawn. The repair and retrofitting works cost a lot of money. Generally, that costs must be funded by the owner or contractor of new construction project. The cost of repairs is nearly 50% of the cost of building a new residential building. If it is possible, excessive surcharge fill loading should be avoided or contractor should consider constructing simple foundation to support the surcharge fill based on technical standards. Construction works in a dense urban housing areas can potentially damage neighboring buildings. Thus, some important things should be concerned to prevent damage from adjacent construction works. First, construction projects needs careful planning by the design team. Second, surveys and investigation to adjacent building and structures, prior to construction and post-construction observation. It should be done to have accurate data of pre-existing damage and damage caused by construction works. Third, a well-planned foundation design, including settlement analysis and sequencing works. Fourth, good communication and coordination between contractors and owners of neighboring building to minimize the potential conflicts during or after construction works.

Acknowledgement

The authors gratefully acknowledge the Public Housing and Settlement Areas, Cipta Karya, and Spatial Planning Department, Surabaya City and East Java Regional Police, Indonesian National Police for good collaboration to resolve disputes in construction projects.

References

[1] Smith NB and Vatovec M 2015 Interpreting Damage to Existing Structures Adjecent to Construction Sites *Forensic Engineering, ASCE* p 113
[2] Cosgun T, Sayin B, Akcay C and Yildizlar B 2016 Damages in Adjacent Structures due to Foundation Excavation *Proc. of the Fourth International Conference on Advances in Civil, Structural and Environmental Engineering - ACSEE 2016 (Rome – Italy)* (Institute of Research Engineers and Doctors, USA) p 77
[3] Vatovec M, Keley P, Brainerd M and Russo C 2010 Mitigation of Damage to Buildings Adjecent to Construction Sites in Urban Environments *Structure Magazine* p 10
[4] Chenari R J and Mohafezatkar A 2010 Adjacent Building Induced Settlement Reduction in Residential Constructions *Forensic Approach to Analysis of Geohazard Problems* (Mumbay) p169
[5] Sereshkeh A M and Chenari R J 2017 Induced Settlement Reduction of Adjacent Masonry Building in Residential Constructions *Civil Engineering Journal* Vol **3** No 7 p450
[6] Eslami A and Moghaddasi H 2018 Complications Caused by Neighboring and Building Construction in Urban Areas- Three Case Studies *Civil Engineering Research Journal* Vol **5** No 4 p143
[7] Das B M 1999 *Principles of Geotechnical Engineering* California : PWS Publishing