

Comparative and Analysis of Top Down and Bottom Up Construction Methods

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Abstract: Basement construction is done sequentially from the bottom to the top and this method known as bottom-up construction method. The work began on the foundation work, excavation work then furthered to the manufacture of columns, beams and plates are constantly up to the roof. Top-down construction method for basement construction is another innovations approach rather than bottom up method. Howard Johnson Hotel with 18th floors located in the middle of large city is considered in this study. The main contractor of the Howard Johnson Hotel project decided to apply top-down construction method for the 2 levels of basement. This study compares the construction methods of bottom-up and top-down in terms of time difference. The comparative analysis result indicated that the time requires for top-down construction method is 49 days less than the bottom-up construction method.

Keywords: Bottom up, Top down, Construction method

I. INTRODUCTION

The construction of basements in high-rise buildings is increasing due to high demand of parking lots as the number of vehicles continuously increases and limited availability of land in city. The primary factors that needed to consider for the construction are the soil, provision of complicated temporary support works and the sensitive environment around the project site [1, 2]. The construction method that is often used in the field project is the bottom-up method which starts from the making of the foundation or excavation of the soil (with the planned depth) for the needs of making a basement floor of a high rise building. With technological developments and engineering techniques, top-down method is now available in the field of construction [3, 4]. The implementation of top-down method does not start from the bottom basement floor (excavation basis) and suitable for the construction of large urban buildings [5]. Both construction methods have differences during work and during the construction process. The bottom-up approach for basement construction was reported to facing the problem such as groundwater leakage during the excavation process and delay the overall project complete duration [1].

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The additional solution to the problem such as dewatering may require more amounts of time and cost to complete the project as well as negative impacts to the surrounding environment, especially to residents' homes. Besides that, Firti et al. (2015) study also shows that top-down construction method has shorter time and low cost compare to bottom-up construction method by 53 days and about Rp. 1.196.315.909,00 respectively[6].

This study considers the Howard Johnson Hotel construction project which located at JalanChairil Anwar (Makassar). This project planned to construct a 2 story basement building to a depth of 8 m below the ground which was used as a parking lot. The main constructor of the project is PT. PP (Persero) Tbk. They wanted the construction to complete as quickly as possible as the project location is adjacent to the residential place, so the construction should not disturb the surrounding environment especially the traffic. Thus, they consider the top-down construction method in their project. Hence, this study aims to compare the two construction methods in terms of construction time.

II. METHODOLOGY

This study involved primary data and secondary data collection. The primary data are obtained direct from the project through survey and observation while the secondary obtained from the literature reviews. The work breakdown structure and work diagram are developed to manage the flow of this study. The duration plan (Top-Down Construction Method) and (Bottom-UP Construction Method) are analyze for the duration to complete the construction.

The Construction Methods

The construction stage for top-down construction method is shown in Figure 1. The construction stages with the bottom-up construction method in Howard Johnson Hotel project is shown in Figure 2. Both figures highlight the important construction stages for each method.

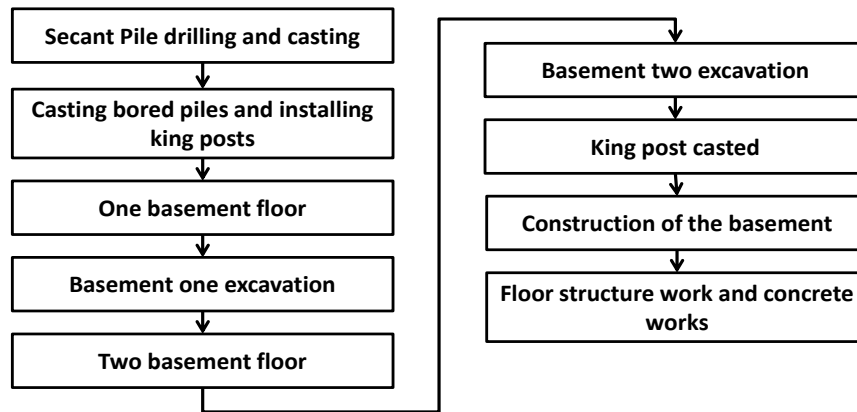


Fig. 1 The flow of constructions stages for top-down construction

Based on Figure 1, the top-down constructions work start with secant pile drilling and casting. Next, the bored piles are casted and the king posts are installed. The one basement floor is constructed by cast on the ground with a working floor follow by basement one excavation. After that, the construction of the second basement floor is constructed by casted on the ground with a working floor follow by basement two excavations. Then, the king post is casted as a structure column. Besides that, for the construction of the basement, the upper structure can be started according to the ability of the existing king post (up & down system). Lastly the construction work completed by floor structure work and concrete work.

Figure 2 demonstrates the constructions stages for bottom-up construction begins with retaining wall. The retaining wall used 800mm diameter of secant pile. Next, the work of bored pile foundation is planned and Ø 800 and 1000mm of bored pile is used. After that, excavation work is conducted. Then the B2 A floor structure work up to B1 A and B1 B floor structure work up to B2 B. Lastly, the construction work complete by floor structure work and concrete works.

III. RESULT AND DISCUSSION

Job Duration Analysis

The duration of working hours (work time) is calculated by using productivity analysis. The calculation can be seen in equation 1.0.

The volume of mountain rock foundation work: 12.89 m³ and 1 day productivity: 8 m³ / day.

$$Duration = \frac{Volume}{productivity} = \frac{12.89}{8} = 1.611 \approx 1 \text{ day (1.0)}$$

Table 1 indicates the tool / worker productivity data used. This data is primary data obtained directly from project data. Table 2 and 3 show the job duration table for both top down and bottom up method respectively.

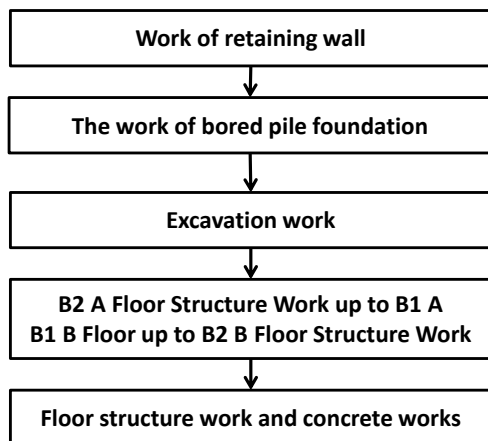


Figure 2. The flow of constructions stages for bottom-up construction

Table 1. Tool and worker productivity data

TOOLS / WORKERS	UNIT	PRODUCTIVITY
Bored Pile Machine	M / day	15
Excavator PC-200	M3 / hour	48
Excavator PC-40	M3 / hour	18
Dump Truck	M3 / hour	23
Clamshell	M3 / hour	30
Concrete Pump	M3 / hour	45
Concrete Reinforcement	KG/ORG/HR	285
Formwork	KG/ORG/HR	16

Table. 2 Job duration table for top down method

JOB NAME	Duration (Days)
BELOW STRUCTURE WORK	201
BASIC FLOOR WORK A	24
BASIC FLOOR WORK B	26
BASEMENT FLOOR WORK B1A	29
BASEMENT FLOOR WORK B1B	34
BASEMENT FLOOR WORK B2A	55
BASEMENT FLOOR WORK B2B	56
BELOW STRUCTURE WORK B	41
CONCRETE WORKS Lt 2	91
CONCRETE WORKS Lt 3	91
TOP DOWN METHOD	423

Table. 3 Job duration table for bottom up method

JOB NAME	Duration (Days)
BELOW STRUCTURE WORK	104
BASEMENT FLOOR WORK B2A	45
BASEMENT FLOOR WORK B2B	51
BASEMENT FLOOR WORK B1A	20
BASEMENT FLOOR WORK B1B	23
BASIC FLOOR WORK A	24
BASIC FLOOR WORK B	26
CONCRETE WORKS Lt 2	91
CONCRETE WORKS Lt 3	91
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From the results of the analysis of two methods than shown in job duration table, the construction of the structure with the top down method for the basement section takes longer than the bottom up constructive method with a difference of 35 days. The construction of the structure with the top down method up to the upper floor requires a shorter time compared to the bottom up constructive method, which is a difference of 49 days. On the other hand, Top-down construction methods require precision and specific competencies in the construction at each stage of construction.

IV. CONCLUSIONS

The construction of top-down methods is faster than bottom-up method, but requires precision and expertise in the construction process. There is a need for technology development to promote the use of top-down methods in construction services in Indonesia.

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