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Cost Comparison of Conventional Floor Slab and Steel Deck Slabs

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Abstract— *Research Objectives "Comparative Analysis of Concrete Slab Construction Using Steel Deck and Conventional Concrete in the Construction of the Joint Lecture Building (GKB State University of Malang). Analysis of the difference in time for casting concrete floor plates using wood formwork with comparison using steel floor deck formwork (permanent formwork). Analysis strength comparison between steel deck slab structure and conventional slab structure. The method in this research is done by collecting data in the form of secondary data, namely Unit Price Analysis and Primary data, namely BoQ and Working Drawings of the Construction of the Joint Lecture Building (GKB) State University of Malang (UM). Analysis stage begins with structural analysis of conventional floor slabs and Steel deck slabs. After that calculate the volume of work, and cost analysis. The last stage of this research is to find cost efficiency between the conventional floor slab method and the steel deck floor slab method. The results of iron work in steel deck floor slab work using wiremesh used is M8-150 so that compared to conventional floor slab work using ordinary reinforcement, it produces different requirements. Where the floor slab used in conventional floor slabs is D10-150 replaced with M8-150 wiremesh reinforcement which has a better quality because it is manufactured. So that the required volume of reinforcement produced is also different with different costs. The steel deck profile that resembles the letter W makes the need for concrete on the floor slab different from ordinary floor slabs in general. As in this study, the use of a steel deck with a W wave height of 55 mm caused a reduction in the net thickness of the floor slab, so that the initial thickness of the floor slab was 120 mm and was increased to 155 mm to meet the comfort factor of the floor slab. Therefore, the need for concrete also changes because the net thickness for conventional floor slab work is 120 mm while the thickness for steel deck slab work is 127.5 mm.*

Keywords— *Cost, conventional floor slabs, steel deck slabs.*

I. INTRODUCTION

Construction companies continue to compete to find methods in the world of building construction so that in a short time and with minimal costs they get products or services that have high quality.[1]. The selection of the method used and the right material greatly affects the success of the project because it has an impact on cost productivity and implementation methods. Structural work, especially floor slab work, is one part of the construction that takes a long time in the manufacturing process. Many contractor companies that exist today are still using conventional methods. The conventional method takes a long time because it still uses ordinary reinforcement, concrete, and wood formwork. So that companies providing construction products or services compete to find alternative construction methods for slabs. [2]

The calculation of this floor slab cannot be separated from the calculation of the budget plan and work time. The calculation of RAB and work time on this building aims to find out the costs incurred and the materials or tools used as well as the number of workers needed. This budget is calculated carefully, carefully and fulfills the existing requirements. [3]. In addition to cost and time calculations that need to be taken into account again is the strength of the floor slabs, according to [4], the floor slabs only take into account the presence of fixed loads (occupants, furniture, tile weight, plate self-weight) that work continuously for a long time. While unexpected loads such as earthquakes, winds, vibrations are not taken into account.

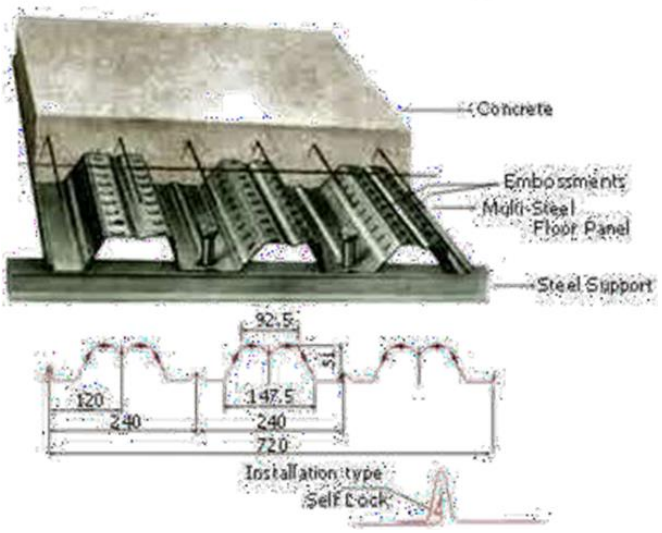

Fig. 1. Steel Deck Floor Plate

The corrugated steel plate or better known as bondek is the main component of making concrete floor slabs that are used as permanent formwork and also work floors. Bondek has a thickness ranging from 0.75 mm to 1.40 mm. And has a width of 1 m. But there is a company that produces the bondek which has many choices of widths needed, namely 890 mm, 950 mm, and 1000 mm. The length required to order a bondek is a maximum of 12 m, depending on the desired order.

Steel deck plates are widely used for the renovation of shop houses, factories, prayer rooms, and mosques into two or more floors. Bondek plate in the form of waves. The material is made of steel with a thickness of 0.75 mm – 1.2 mm. The slab is up to 12 m long and 1 m wide. The installation is directly "held" on top of the IWF concrete or steel beams [5].

Steel deck installation is easier and faster than the installation of conventional formwork which generally takes longer and requires a professional workforce in assembling it so that there is no leakage or collapse of the formwork.

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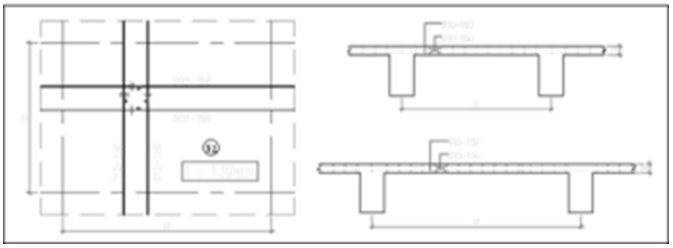

Fig. 2. Conventional Floor Plate

The implementation method of conventional concrete floor slabs is carried out in stages. That is, first, the installation of the formwork, then after the formwork is complete, the iron is assembled as concrete reinforcement, after the iron is completed, the concrete is poured, and the last is the demolition of the formwork after the concrete has hardened or 14 days after the casting is complete.[6]

The implementation of the conventional concrete floor slab work first determines the height of the floor slab, the second is the installation of the floor slab formwork, the third is the casting of the floor slab, and the last is the demolition of the floor slab formwork [7].

II. METHOD

The floor plate is one of the structural elements in a building construction consisting of a long span called Ly and also a short span called Lx. There are two types of floor slabs, namely one-way floor slabs and two-way floor slabs which are reviewed based on the ratio of Ly compared to Lx, where for the value of Ly/Lx more than two, it is included in the one-way slab while if it is less than two then it is included in the slab. two-way type. The difference between the one-way slab and the two-way slab apart from the ratio between Ly and Lx is the reinforcement system.[8]

According to Frick, et al [9], the floor slab is an element in the horizontal plane of the building. The floor slabs divide the space at its height, forming a multi-storey building (flat). Like walls, floor slabs function as vertical space dividers, and accept structural loads such as dead loads, load loads, wind, earthquakes. According to Asroni, (2007) [10], the floor slab is a thin plane structure made of reinforced concrete with a horizontal direction, and the load acts perpendicular to the plane of the structure. Reinforced concrete slabs are widely used in civil buildings, both as building floors, roof floors of a building, bridge floors and pier floors. The load acting on the slab is generally calculated against the gravity load (dead load and/or live load).

Concrete is defined as “a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without admixture” (SNI 2847:2013, 2013;17). And reinforced concrete is also defined as "reinforced concrete with an area and amount of reinforcement not less than the required minimum value with or without prestressing, and is designed based on the assumption that the two materials work together in resisting the acting force" (SNI 03 - 2847-2002, 2002;6).

The object of this research is the Joint Building Development Project (GKB) State University of Malang (UM) which is located on Jl. Bogor Simpang No. 5 Malang City. The focus in this research is related to the comparison of steel deck concrete slab construction and conventional concrete slab in terms of strength, time, and cost.

The implementation method compared in this study is the steel deck concrete slab method and conventional concrete slab where the comparisons reviewed are in terms of strength, time, and implementation costs of the two methods.

There are several data that support this research, including list of materials and wages data, bill of quantity (BoQ) data, analysis data of steel deck concrete slab unit prices, and working drawing data.

In this study, the calculation of the implementation time of the steel deck concrete slab based on the bill of quantity data and the price analysis data for the steel deck concrete slab work unit was carried out to determine the length of time for the floor slab work, such as the time for installing the floor deck (steel deck), the time of the reinforcement fabrication work, and casting time.[11]

In this study, the calculation of the cost of implementing steel deck concrete slabs based on bill of quantity data and data analysis of the unit price of steel deck concrete slab work to determine the cost of floor slab work such as the cost of installing floor deck (steel deck) work, the cost of reinforcing fabrication work, and foundry costs.[12]

In this study, the calculation of the volume of conventional slab implementation based on working drawing data was carried out to determine the volume of floor slab work such as the volume of formwork installation work, the volume of reinforcement fabrication work, and the volume of casting work.[13]

In this study, the calculation of the implementation time of conventional concrete slabs based on bill of quantity data and unit price analysis data for conventional concrete slabs was carried out to determine the length of time for floor slab work such as the time of the installation of floor slabs, the time of the reinforcement fabrication work, and the time of casting work.

In this study, the cost of implementing conventional concrete slabs was calculated based on bill of quantity data and unit price analysis data for conventional concrete slabs to determine the cost of floor slab work such as formwork installation costs, reinforcement fabrication work costs, and casting work costs.

In the installation of steel deck per 16 (sixteen) square meters required steeldeck with a width of 1 m (provided from the factory) and a length of 4 m (according to the span between beams) per sheet required. This means that in a 16 m^2 wide span, four bondek sheets with an area of 4 m^2 are needed with the required coefficient of 16 m^2. After the steeldeck is installed or placed on the desired span, then the wiremesh is placed on top of the steel deck with a size that matches the steel deck.[14]– [16]

JKBL union installation and connection is not difficult, but several things need to be considered so that optimal and correct results are obtained.

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Fig. 3. Steel deck Floor Plate and wiremesh installation

The yield stress lift is lift will be equivalent to the full yield stress if the sheets overlap by one square space (two weld seams), plus a minimum of 2.5 cm. Rise at half yield stress a lift will be equivalent to half the yield stress, if the sheets overlap by one weld seam plus a minimum of 2.5 cm.

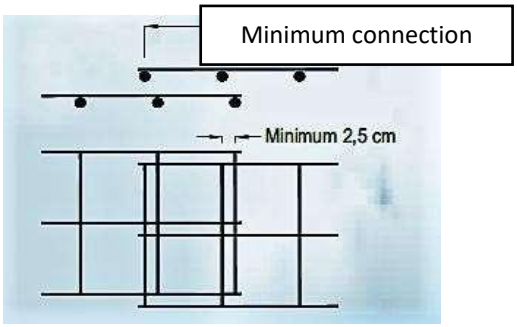

Fig. 4. Fully Melt Stress Lift (5000 Kg/cm^2)

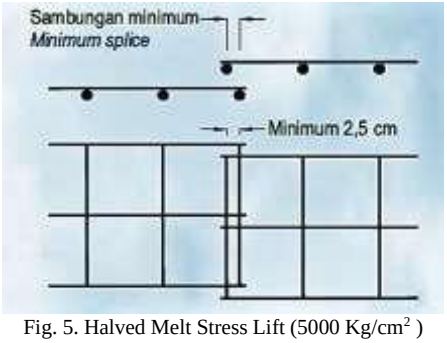

Fig. 5. Halved Melt Stress Lift (5000 Kg/cm^2)

An additional 2.5 cm is the minimum concrete aggregate distance permitted by the Indonesian Concrete Regulations (PBI 8.16.1), helping the concrete to solidify around the wire. The half yield stress lift requirement is sometimes permitted for one-way slab edge lift, but such lift should be determined by the building engineer. It is recommended that the lift be used as strong as the yield stress and placed at points where the tensile stress is not maximum. (Union Wire Mesh® PT. Union Metal, Brochure, 2017)

III. Result and Discussion

An additional 2.5 cm is the minimum concrete aggregate distance permitted by the Indonesian Concrete Regulations (PBI 8.16.1), helping the concrete to solidify around the wire. The half yield stress lift requirement is sometimes permitted for one-way slab edge lift, but such lift should be determined by the building engineer. It is recommended that the lift be used as strong as the yield stress and placed at points where the tensile stress is not maximum. (Union Wire Mesh® PT. Union Metal, Brochure, 2017).

At this stage, the maximum moment acting on the floor slab is 14.8948 kNm. Where with the maximum moment value, the steel deck can be said to be safe to use if the flexural strength has a Mru value greater than Mu, where the maximum Mu lies at the moment. x-direction field. Based on the previous calculations, the Mru value of 15.6417 kNm has been obtained. So that the floordeck is safe to use because the value of Mru> Mu, which is 15,617 > 14,8948 kNm.

However, based on the requirements of SNI 2847:2013, the minimum plate value is 125 mm. This takes into account the convenience of using the building for the sound generated when using a less thick plate. In the calculation above, the researcher uses the thickness of the plate according to the project design. So the thickness used in the calculation is the value of d which is 92.5 mm. The value of d on the steel deck is assumed to be the actual plate thickness applied to the steel deck. This is because the steel deck has a corrugated profile so that the concrete printed on the steel deck plate is at the lowest point of the wave and the highest point of the wave. Therefore, the value of d which has the definition of the measured value from the highest concrete position on the slab to the center of waves is considered as a measure of the actual thickness of the slab. Then, to meet the requirements for the value of d > 125 mm, the h used in the design is 155 mm thick.

TABLE 1. Calculation Result of Flexural Strength

	Unit	**Plate Thickness**	
		120 mm	155 mm
F'c	Mpa	27,5	27,5
As	mm^2	554,166	554,166
b	mm^2	1000	1000
Isf	mm^4	422063,58	422063,58
fy	Mpa	550	550
Ø		0,85	0,85
d	mm	92,5	127,5
hc	mm	65	100
N		7,656748336	7,656748336
P		0,005990991	0,004346405
Ycc	mm	20,26060543	23,64320509
Ycs	mm	72,23939457	103,8567949
Ic	mm^4	3337101,301	6427857,588
My	KNm	18,4020138	26,91388501
Mru	KNm	15,64171173	22,87680226

The following stage is the calculation of the moment acting on the floor slab of the building. At this stage the maximum moment on the conventional plate is sought to be compared with the steel deck with the aim of knowing whether the previous design of the steel deck plate is safe or not. The following are the data needed to obtain the maximum moment acting on a conventional plate.

Based on the analysis of the cost budget plan on the steel deck floor slab that was carried out previously, it was obtained that the cost was Rp. 67,539,423. Then the next analysis is to compare the costs required for floor slab work with

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conventional motedes and also the steel deck method to find out the difference from the budget plan for floor slab work using the conventional method and floor slabs using the steel deck method. Table 2 and table 3 will present a recapitulation of the budget plan of the two work methods.

TABLE 2. Total of the Steel Deck Plan Cost Budget Floordeck Methods

No	Item	Cost (Rp)
1	Storey 4	58.765.436
2	Storey 3	8.773.987

TABLE 3. Conventional Plate Budget Plan Total Conventional Methods

No	Item	Cost (Rp)
1	Storey 4	66.855.351
2	Storey 3	10.242.381

From the table above, it can be seen that the total cost for conventional slab work is Rp. 77,097,732 and also for work on steel deck slabs is Rp. 67,539,423.

In this study, the formulation of the problem reviewed by the author is to determine the existing condition of the floor slab at GKB UM, then the formulation of the problem reviewed by the author is how the results of the calculation of the strength comparison between the steel deck plate and conventional slab are, then how much is the result of the evaluation of the cost difference required from the slab work. steel deck concrete and conventional concrete slabs. Based on the recapitulation of the budget plan for the two floor slab work methods that have been analyzed previously, it can be seen that the use of steel deck plates is more efficient or cheaper than the use of conventional floor slabs.

The results of the analysis on the budget plan show that the difference obtained from the budget plan for steel deck and conventional plates is Rp. 9558.265,-. The difference is the difference in the total cost between the work of floor slabs 3 and also floor slabs 4 which also proves that the use of floor slabs with the steel deck method is cheaper and more efficient than conventional floor slabs. After obtaining the value that the steel deck floor slab is cheaper so that the percentage intended by the researcher can be known as 12.39%.

IV. Conclusion

Iron work in steel deck floor slab work using wiremesh. The wiremesh used is M8-150 wiremesh so that compared to conventional floor slab work using ordinary reinforcement, it produces different requirements. Where the floor slab used in conventional floor slabs is D10-150 replaced with M8-150 wiremesh reinforcement which has a better quality because it is manufactured. So that the required volume of reinforcement produced is also different with different costs. The steel deck profile that resembles the letter W makes the need for concrete on the floor slab different from ordinary floor slabs in general. As in this study, the use of a steel deck with a W wave height of 55 mm caused a reduction in the net thickness of the floor slab, so that the initial thickness of the floor slab was 120 mm and was increased to 155 mm to meet the comfort factor of the floor slab. Therefore, the need for concrete also changes because the net thickness for conventional floor slab work is 120 mm while the thickness for steel deck slab work is 127.5 mm.

References

[1] W. I. Ervianto, "Manajemen proyek konstruksi," *Andi, Yogyakarta*, 2005.
[2] A. David, "Structura morbidității rinitei alergice la copii în Republica Moldova," *Bulletin of the Academy of Sciences of Moldova. Medical Sciences*, vol. 54, no. 2, pp. 298–304, 2017.
[3] A. S. Sastraatmadja, "Analisa anggaran biaya pelaksanaan," *Bandung: Nova*, 1984.
[4] H. B. Setiawan, "Perencanaan Struktur Baja Komposit Pada Gedung Hotelq Denpasar Bali Dengan Sistem Rangka Pemikul Momen," 2015.
[5] M. MISTRA, *The rise and decline and rise of China: Searching for an organising philosophy*. African Books Collective, 2015.
[6] M. H. b Osman, L. bin Imran, H. binti Tami, N. A. bt Abdul Rahman, and S. bin Salim, "Anchor Bolt Position in Base Plate In Terms Of T and J Anchor Bolt," *MATEC Web Conf.*, vol. 97, p. 01110, 2017, doi: 10.1051/matecconf/20179701110.
[7] H. C. Hardiyatmo, "Metoda Hitungan Lendutan Pelat Dengan Menggunakan Modulus Reaksi Tanah Dasar Ekivalen Untuk Struktur Pelat Fleksibel," 2009.
[8] V. Aditama, S. M. Dewi, and A. Zacoeb, "Bamboo Knit Reinforcement Concrete Plates as Walls to Resist Lateral Load".
[9] H. Frick, "Pujo. L Setiawan," *Ilmu konstruksi struktur bangunan, Yogyakarta, Penerbit Kanisius*, 2001.
[10] A. Asroni, D. Mutiari, and R. Z. Islam, "Tipologi Bentuk Arsitektur Masjid di Surakarta," 2007.
[11] P. Imbeau, "Response Of Reinforced Concrete Columns Subjected To Impact Loading," 2012.
[12] J. A. Grant, J. W. Fisher, and R. G. Slutter, "Composite beams with formed steel deck," *Engineering Journal*, vol. 14, no. 1, 1977.
[13] M. L. Porter, H. A. Elleby, L. F. Greimann, and C. E. Ekberg Jr, "Shear-bond analysis of steel-deck-reinforced slabs," *Journal of the structural Division*, vol. 102, no. 12, pp. 2255–2268, 1976.
[14] H. Rezaeian, G. C. Clifton, and J. B. Lim, "Failure modes for composite steel deck diaphragms subjected to in-plane shear forces–A review," *Engineering Failure Analysis*, vol. 107, p. 104199, 2020.
[15] J. Zhu, W. Zhang, and X. Li, "Fatigue damage assessment of orthotropic steel deck using dynamic Bayesian networks," *International Journal of Fatigue*, vol. 118, pp. 44–53, 2019.
[16] J.-F. Zhang *et al.*, "Experimental study on seismic performance of the connection for ATLS modular house," *Journal of Constructional Steel Research*, vol. 170, p. 106118, Jul. 2020, doi: 10.1016/j.jcsr.2020.106118.