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Study Of Compressive And Flexural Strength Of Concrete Using Bima Cement For National Road Reconstruction In Kebumen

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Abstract. *Concrete is an important aspect of building construction, one of which is road construction. Concrete is used for road construction because it has the advantages of high compressive strength, easy maintenance, ease of formation, and easy to obtain components. Road construction using concrete is applied to the reconstruction of the Kebumen South Ring Road, where the Kebumen South Ring Road is a 9.07 km long national road. National roads are arterial and collector roads in the primary road network system that connect provincial capitals, national strategic roads, and toll roads. Therefore, construction on national roads requires strong and good materials on the Kebumen South Ring Road to optimize road use. In this study, the concrete is composed of Bima cement as Portland cement, coarse aggregate from Kebumen, fine aggregate from the Progo River, and water from drilled wells. The admixture was obtained from a Conmix HK 2. Subsequently, all ingredients were mixed using a mixer truck. The concrete mixture was molded into cylinders and blocks. In this study, the average results of the 5-day concrete compressive strength test were obtainedwhich is 373.42 kg/cm2 and 28-day-old concrete is 442.32 kg/cm2. The average result of the 5-day concrete flexural test is50.65 kg/cm2 and that of 28-day-old concrete was 60.73 kg/cm2. The results are in accordance with the general specifications of the Bina Marga, namely, 45 kg.*

Keywords: *Bima cement, concrete, compressive strength, flexural strength, Kebumen.*

1. INTRODUCTION

Roads are a type of land transportation infrastructure that play an important role in economic growth, socio-culture, tourism area development, and defense and security to support national development. Therefore, it is necessary to build an adequate road network to provide optimal services according to the required capacity. There needs to be an increase in the quality of the road system and infrastructure within to 2-3 years, such as the need for safe and comfortable roads (Rahmat*et al*, 2017; Subagyo, 2023). Thus, the construction of national roads requires this, one of which is the 9.07 km long Kebumen South Ring Road. Kebumen South Ring Road connects the capital cities of Central Java, Yogyakarta, and West Java. The construction of Kebumen South Ring Road uses concrete as a road pavement. This pavement is used on roads that have quite dense traffic conditions and a large load distribution, such as inter-provincial roads, toll road flyovers, and signalized intersections (Rahmat et al, 2017). This was in accordance with the conditions of the Kebumen South Ring Road.

Concrete is a construction material that has been in use for thousands of years. In the 17th century, concrete continued to develop in the composition of its constituent materials, particularly cement. At present, concrete is made on the basis of careful

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planning, namely, by using a composition of materials that have previously undergone a selected process and whose properties are known so that the concrete can be optimized for strength (Rahamudin et al, 2016). Concrete road pavements are commonly called rigid pavements and consist of Portland cement concrete slabs and a foundation layer on the subgrade. Rigid concrete pavements with a high modulus of elasticity distribute the load to a fairly large area of land, so that the largest part of the pavement structure capacity is obtained from the concrete slab itself (Saepudin et al, 2023).

The concrete composition was a mixture of Portland cement, fine aggregate, coarse aggregate, and water with or without admixtures to form a solid mass. Water and cement were then mixed to form a paste called cement paste. This cement paste, in addition to filling the pores between the fine aggregate and coarse aggregate grains, also acts as an adhesive or binder in the binding process, so that the aggregate grains are strongly bonded to each other (Saepudin et al, 2022; Nasution et al, 2021). Cement is a very important ingredient in concrete mixtures and must be in accordance with the plan and specifications of the materials provided. Aggregate is one of the filler materials in the mixture; however, the role of the aggregate in concrete is very important because it affects the properties of concrete (Tjokrodimuljo, 2007). The advantages of concrete are its high compressive strength, low corrosion properties, ease of maintenance, ease of formation, ease of obtaining components, relatively cheap prices, and heat resistance. However, concrete has disadvantages such as low tensile strength, easy damage, expansion when the temperature changes, difficulty in waterproofing, and brittleness (Tjokrodimulyo, 1996; Sumardi et al, 2023).

In this study, the selection of concrete material composition was carried out such that the compressive strength and flexural strength of concrete have optimal values when used in the construction of the Kebumen South Ring Road. The compressive strength of concrete indicates the quality of the structure. The higher the desired level of structural strength, the higher is the quality of the concrete produced. Meanwhile, flexural strength indicates the strength of the concrete when deformed or when the concrete can withstand external loads (Rahamudin et al, 2016). The Kebumen South Ring Road is a national road with dense traffic and a large load distribution; therefore, concrete with optimal compressive and flexural strength is needed. The selection of the concrete material composition was in accordance with the 2018 Bina Marga specifications.

2. RESEARCH METHODOLOGY

This study was conducted at PT. Karya Adi Kencana Kebumen on June 24, 2024. The compositions of the concrete materials used in this study are listed in Table 1.

Table 1. Composition of concrete materials

No	Material	Type	Origin	Specific Gravity (kg/m3)	SSD	Volume (m3)
1	Portland cement	OPC Type 1	Bima	3000	460	0.153
2	Coarse aggregate 20-30	Broken stone	Kebumen	2554	1034	0.405
3	Fine aggregate	River sand	Progo River	2690	764	0.284
4	Water	Artesian water	Boreholes	998	147	0.147
5	Admixture	Type G	Conmix HK 2	1120	5.06	0.005

There are two types of concrete molding tools: cylinders and blocks. The dimensions of the concrete molds are shown in Figure 1.

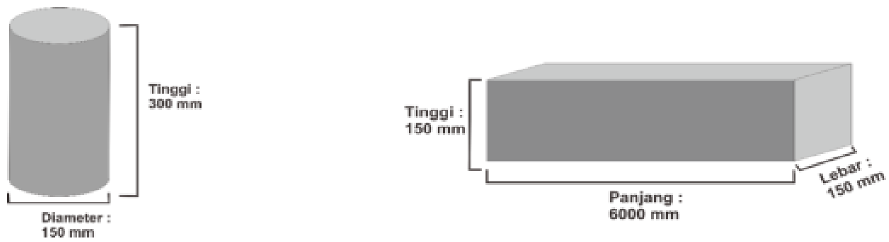

Figure 1. Concrete mold dimensions and their dimensions (Cylinder and Beam)

The concrete mixing mold containers are presented in Figure 2 in the form of cylinders and blocks.

Figure 2. Concrete mold shapes (cylinder and block)

Then, the concrete materials listed in Table 1 were mixed in a mixer truck. After forming a concrete mixture, a slump test was conducted on the concrete mixture. Then, the concrete mixture in the mixer truck was molded in the form of cylinders and blocks, as shown in Figure 2. The concrete was made of 12 samples each for the cylinder and block shapes. Next, the specimens were allowed to dry for 5 and 28 d to carry out the compressive and flexural strength tests. Cylindrical concrete was used for the compressive strength test, and block concrete was used for the flexural strength test. Compressive and flexural strength tests were performed at the Central Java-DI Yogyakarta National Road Implementation Center.

3. RESULTS AND DISCUSSION

In this study, the concrete was mixed using a mixer truck. It was then poured into a container to be molded in the form of a cylinder and block. The results for the concrete mixture in the mixer truck are presented in Figure 3.

Figure 3. Results of mixing concrete with a mixer truck

One method used to determine the workability of a concrete mixture is to check its slump value. The slump value is the difference between the height of the mixture in a truncated cone-shaped mold and the height of the mixture after the mold was removed. The slump was measured for each casting (Pane et al, 2015). The slump test used in this study is shown in Figure 4.

Figure 4. Slump testing on concrete mix

The results of the concrete mixture test indicated that the initial slump value was 10 cm. After being left for 45 min, the slump value was 7 cm, so that a difference of 3 cm was obtained for the slump test. For rigid pavement planning, the required slump value is 5–7 cm (Bina Marga, 2018), based on the slump value, it meets the requirements for rigid pavement planning. Based on Bina Marga, the results for the concrete mixture show a slump value that meets the requirements for rigid pavements. The results of the concrete mixture that was placed into the mold are presented in Figure 5.

Figure 5. The results of the concrete mixture that has been put into the cylinder and block molds.

Figure 5 shows the results of the concrete mixtures that were inserted into the cylinder and block molds. A cylindrical shape was used for the compressive strength tests and a block for the flexural strength tests. After the concrete was 5 and 28 days old, compressive strength and flexural strength tests were performed. This test was conducted at the Central Java-DI Yogyakarta National Road Implementation Center. The following are the results of the compressive strength tests on 5-day-old concrete presented in Tables 2 and 3 for 28-day-old concrete.

Table 2. Results of 5-day-old concrete compressive strength test

Area of field (mm2)	Weight (kg)	Compressive force (N)	Results (kg/cm2)	Average (kg/cm2)	% Results
17617.5	12.70	535000	371.69	373.42	124%
17617.5	12.90	540000	375.16		

Table 3. Results of 28-day concrete compressive strength test

Area of field (mm2)	Weight (kg)	Compressive force (N)	Results (kg/cm2)	Average (kg/cm2)	% Results
17617.5	12.95	690000	479.37	442.32	147.44%
17617.5	12.95	620000	430.74		
17617.5	12.65	600000	416.85		

Based on Table 2, the average concrete compressive strength test at the age of 5 days was 373.42 kg/cm2. At the age of 28 days, there is an increase in the weight of the concrete; therefore, it is necessary to add a compressive force for the compressive strength test. As shown in Table 3, the average concrete compressive strength test at the age of 28 days was 442.32 kg/cm2. Based on Tables 2 and 3, there was an increase in the compressive strength of the concrete; the harder the concrete, the greater the compressive strength value. The flexural strength test of the concrete broke at the center 1/3 of the width of the tensile side. The results of the flexural strength test for the 5- and 28-day-old concrete are presented in Table 4.

Table 4. Results of flexural strength test of 5-day-old concrete

Distance between 2 points (mm)	Weight of test object (kg)	Maximum load (N)	Results (kg/cm2)	Average (kg/cm2)	% Results
450	32.95	36900	50.17	50.65	107.76
450	33.70	37600	51.12		

Table 5. Results of flexural strength test of 28-day-old concrete

Distance between 2 points (mm)	Weight of test object (kg)	Maximum load (N)	Results (kg/cm2)	Average (kg/cm2)	% Results
450	34.10	44900	61.05	60.73	129.21
450	33.00	45200	61.46		
450	32.85	43900	59.69		

Based on Table 4, the average flexural strength test of concrete at the age of 5 days was 50.65 kg/cm2 and Table 5 shows that the average flexural strength test of concrete at the age of 28 days was 60.73 kg/cm2. At the age of 28 days, there was an increase in the weight of the concrete; therefore, additional loads were required for the flexural strength test. Based on Tables 4 and 5, there was an increase in the flexural strength of the concrete; the harder the concrete, the greater the flexural strength value. This shows that the flexural strength test of the concrete exceeded the standard value of the 2018 Bina Marga specifications, which is 45 kg/cm2; thus, the concrete that was produced based on the composition in Table 1 can be used for road construction on the Kebumen South Ring Road.

4. CONCLUSION

Concrete application as National road construction on Kebumen South Ring Road, where Kebumen South Ring Road is 9.07 km long. Therefore, strong and good road construction on national roads is needed on Kebumen South Ring Road to optimize road use. In this study, the concrete used was Bima cement as Portland cement, coarse aggregate from Kebumen, fine aggregate from the Progo River, water from drilled wells, and admixture from Conmix HK 2. The mixture was then mixed using a mixer truck. Concrete was molded in the form of a cylinder for compressive strength testing and a beam for flexural strength testing. In this study, the average results of the 5-day concrete compressive strength test were obtainedwhich is 373.42 kg/cm2 and 28-day-old concrete is 442.32 kg/cm2. The average result of the 5-day concrete flexural test is50.65 kg/cm2 and that of 28-day-old concrete was 60.73 kg/cm2. The results are in accordance with the general specifications of the Bina Marga, namely, 45 kg/cm2.

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