

## **A Review of Investigation on Strength Development of Concrete with Ordinary Portland Cement and Portland Composite Cement**

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**Abstract:** Nowadays, the construction of the building has been using concrete as the main ingredient for their structure. It can indicate as the core for production of each building. The concrete must be in its best condition to prevent the structure works from having any problem during the phase of construction. Concrete in general is a mixture of fine aggregate, coarse aggregate, cement, and water. For cement, there has been two type of cement that has been used now in construction which is Portland cement and composite cement. For Portland cement it is the composition of calcium compound, silica, alumina, and iron oxide that has been through chemical process. For composite cement, it is a mixture of high-quality clinker, fly ash, granulated slag, and gypsum. But lately there has been high demand for the usage of composite cement in the concrete mix. For this research it has indicate the review for strength of concrete with usage between the two types of cement which is Portland cement and fly ash composite cement. The review has been write based on the previous research that has been done. The data has been sought to find the pattern for development of compressive strength of concrete that contain Ordinary Portland Cement and Fly ash Composite Cement and the result from it can be seen that the development for the early strength for the Ordinary Portland Cement is higher than Portland Composite Cement. The data collected also has been analysis for the increment gain for the compressive strength development between the period of time between day 1 to day 365. It can be seen that the increment of the high-grade concrete is higher than the low-grade concrete.

**Keywords:** Compressive Strength, Portland Composite Cement, Ordinary Portland Cement

## 1. Introduction

Construction has become an important part in the society as Malaysia has been moved towards the developed country. There has been many technologies and method that has been used in the construction phase. One of the important materials that has been used in the construction is concrete as it is widely to be used to make structure parts such as beam, column, slab, and others. Although there have been many technologies that has been used to replace this material which is concrete, but it is still majorly used in the construction site in the wide world. Concrete is a combination of aggregates, typically sand, and gravel or ground stone that is bound together by a cementitious paste binder [1]. Then it can be said that there have been many types of cement that has been used to make the mixing of concrete. There have been many types of cement in the market nowadays that has been used as the binder for the concrete.

The type of cement that will be chosen will slightly affect for the type of the concrete that being made. The type of cement that will be use in this research is Ordinary Portland cement (OPC) and Portland Composite Cement (PCC). This chapter will indicate the detail about the type of the cement use and how it will affect in the process to make the concrete mixture and how it will affect the strength of the concrete in the meantime. As it can be seen the strength of the concrete will play a big role in the construction. It is because the strength of concrete will determine the ability of the structure to withstand load from its applicable load that happen on the structure. But the concrete will have the change of performance according to the affecting load status [2].

The strength development will be seen in this test in the period that will be observed through the cube test and cylinder test. Before this test can be done, the mixture needs to be prepared first. There have been many sizes for the cube such as size 150mm x 150mm x 150 mm and 100mm x 100mm x 100 mm. But the most common that has been size that has been use in this practice is 150mm x 150mm x 150mm. It is same as the requirement by the BS EN 206 for sizing of cube. The concrete will be poured into the mold and being tempered carefully to make it even and smooth.

The two scoped that will be study are for the compressive strength of concrete using Portland Composite Cement or Ordinary Portland Cement. Other scope that has been study are the compressive strength of concrete in low and high-grade concrete. The low-grade concrete can be classified from grade 20 to below and the high-grade concrete is a type of concrete that has grade greater than grade 40 [3]. The design for low grade concrete that has been use from research paper is grade 20 [4-7]. For the high strength concrete the design grade that be choose from the research paper is grade 60 [8], target strength 41.37 MPa [9], and target strength of 50.4 MPa [10].

## 2. Methodology

This study's techniques included data collection, data review analysis based on statistical comparison of compressive strength based on the literature.

### 2.1 Data Collection

For this project, the data that need to be search are compressive strength development of high-grade concrete and low-grade concrete. There will be two subtopic or perimeter that need to be insert under the main subject which is the concrete containing Ordinary Portland Cement and concrete containing Portland Composite Cement. The compressive strength of the concrete will be needed for the period between day 1 to day 365. For the article, there will be several online sources that has been gone through such as ScienceDirect, Google Scholar, Malaysian Thesis Online (MYTO) and other.

## 2.2 Data review analysis

The data that has been collected will be review and be analyze whether it is suitable to be use for this paper or not. The data that need to be analyze is the development of compressive strength of concrete using Ordinary Portland Cement and Portland Composite cement on low-grade concrete or high-grade concrete. This set of data will be get from the experiment that has been done by past researcher. The analysis will be done by using Microsoft excel spreadsheet to see the pattern of compressive strength data based on two criteria which is type of cement and which grade that has been used. The data will be analyzing through the increment of strength that has been develop based on the case study.

## 3. Results and Discussion

The comparison will be do for the compressive strength of concrete containing Ordinary Portland cement and Portland Composite cement in low grade concrete and high-grade concrete. Next, the graph also includes the increment gain for the compressive strength development between the period between day 1 to day 365.

### 3.1 Development of Compressive Strength

The development of the compressive strength of the concrete that contain Ordinary Portland Concrete and Portland Composite cement in concrete will be studied here from the previous research data from previous researcher. The concrete usually achieves full strength or design strength at 28 days. Figure 1 shows the comparison strength of concrete contain Ordinary Portland Cement and Portland Composite Cement .

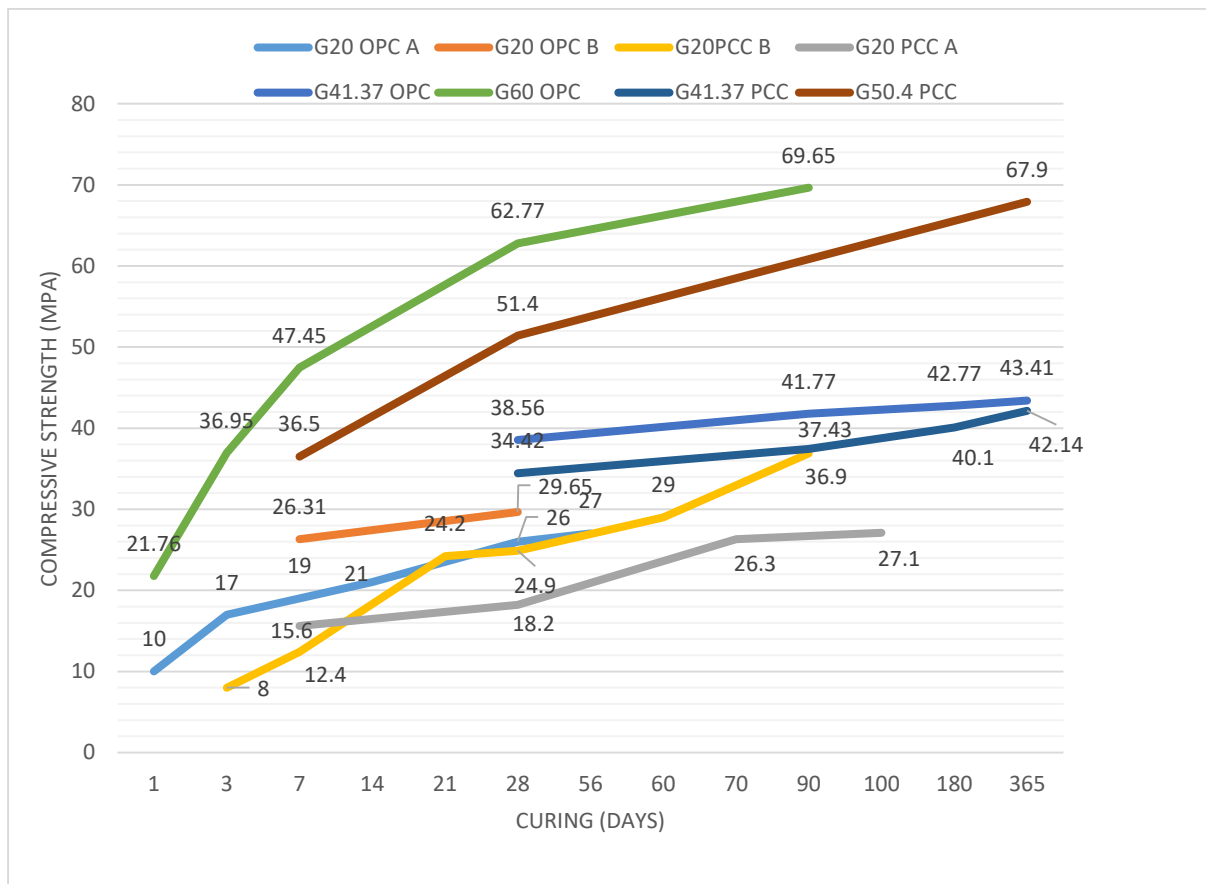
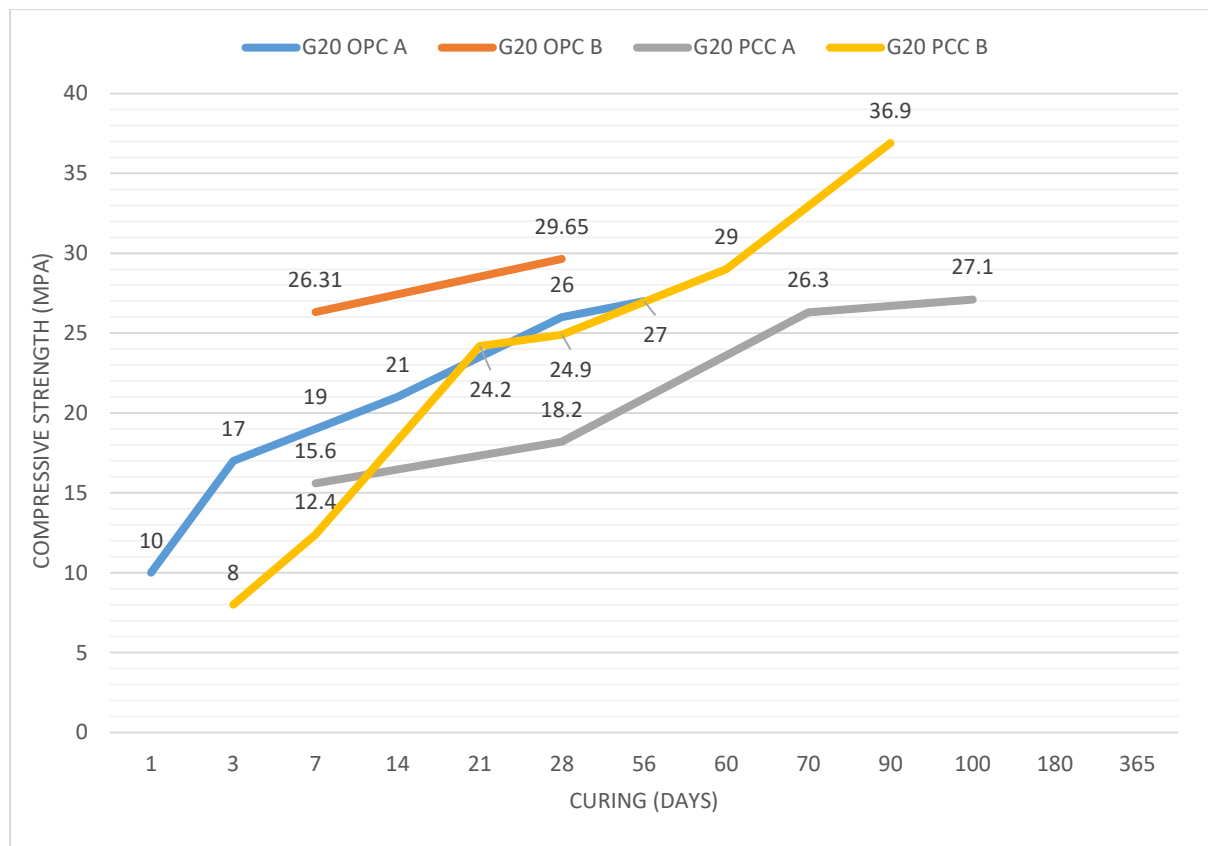


Figure 1: Comparison strength of concrete contain Ordinary Portland Cement and Portland Composite cement low and high grade

The development of strength for the Ordinary Portland Cement and Portland Composite cement can be seen from the grade 20 concrete containing Ordinary Portland Cement and Portland Composite cement. As it can be seen in Figure 1 the development strength of the Portland Composite cement is slow at early age which is before the 28 days rather than compare Ordinary Portland Cement concrete. G20 PCC B only recorded 8 MPa from the strength of 3 days which is lower than G20 OPC A which recorded 17 MPa [4][7]. This is because Portland Composite Cement contain fly ash which is a slow reactive pozzolans that will reduce the hydration reaction [11]. Thus, it is required a longer curing time if it is compared to the Ordinary Portland Cement Concrete to achieve its final strength.

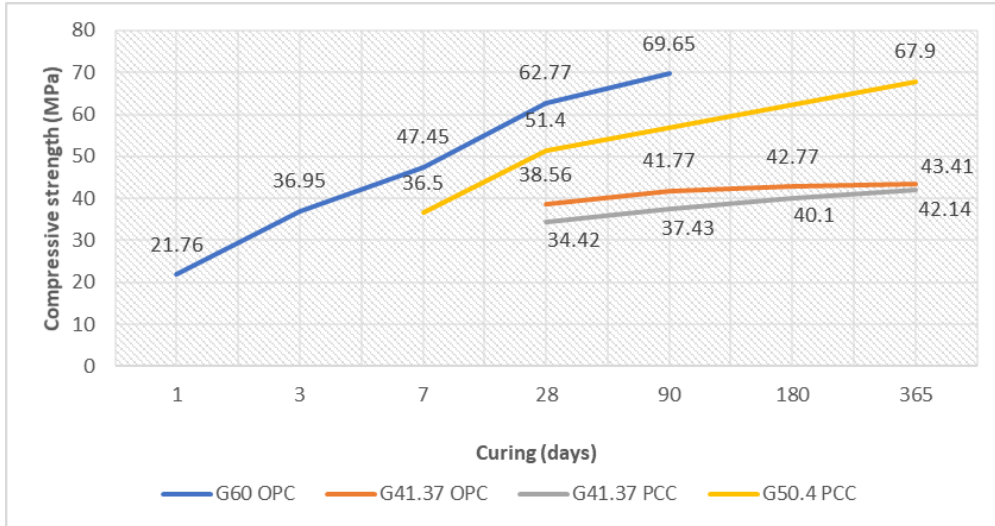
### 3.2 Compressive Strength Comparison for Low-Grade and High-Grade Concrete

The compressive strength of the concrete can be seen from the result that the past researcher has done it through the compression test for the concrete material which is through the low-grade and high-grade concrete. Figure 2 shows the low-grade concrete by the past researcher.



**Figure 2: Compressive strength of low-grade concrete**

For the high-grade concrete, it is containing the data set of the compressive strength concrete that also contain Ordinary Portland Cement and Portland Composite Cement. Figure 3 show the compressive strength of the high-grade concrete containing Ordinary Portland Cement and Portland Composite Cement.



**Figure 3: Compressive strength of high-grade concrete**

For the comparison between the low-grade and low-grade can be seen from the increment of the concrete which contain a same cement contain at certain period. For the G20 OPC A, it has the increment of 3.34 MPa for duration of 7 to 28 days [4]. For the G60 OPC, it has the increment of 15.32 MPa for period of 7 to 28 days [8]. For the G20 OPC A if compared to the G41.37 OPC, it has shown that the increment of high-grade concrete is higher than the low-grade concrete for period 28 days to 56 days [8][9]. The result of the increment is also the same for the G41.37 PCC and G20 PCC A at the same period [9][6]. Lastly, the comparison of the increment of strength for period 7 to 28 days also is high for the G20 PCC B than G50.4 PCC concrete [7][10]. The table 1 has shown the increment of compressive strength for Ordinary Portland Cement or Portland Composite cement in concrete.

**Table 1: Increment of compressive strength**

Curing Period (days)	Concrete grade/ target strength	Compressive strength increment (%)
7 to 28	20.00 OPC	12.7
	60.00 OPC	32.3
	20.00 PCC	100.0
	50.40 PCC	40.8
28 to 56	20.00 OPC	3.9
	41.37 OPC	4.6
	20.00 PCC	8.4
	41.37 PCC	8.7

#### 4. Conclusion

According to the case study that has been use in this research paper, the compressive strength for the Ordinary Portland cement in concrete is higher than the compressive strength for the Portland Composite Cement in concrete at the early age. Thus, the curing time for the Portland Composite Cement concrete will increase to achieve the desired strength. From the case study that has been collected from previous researcher, high-grade concrete whether contain Ordinary Portland Cement and Portland Composite Cement has shown high increment if compared to the low-grade concrete in term of compressive strength. But for the early age, the low-grade concrete has shown the high increment if compared to the high-grade concrete. The high-grade concrete will affect directly to the strength of the concrete as it is the indicator for the concrete at 28 days. The concrete also has shown that it has achieve 99 percent of its strength at 28 days curing age. The future recommendation is adding the other parameters data such as tensile strength, flexural strength and other parameters that may be involve for the strength properties. It also suggested that researcher should be open to the more type of cement and not only Ordinary Portland Cement and Portland Composite Cement to get the more variable of data in future studies. Lastly the curing method for the concrete also need to be various rather than using air curing only such as sprinkling and others.

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