# Determination of the Compressive Strength of Concrete from One to Twenty-Eight Days

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## ABSTRACT

*This study was conducted primarily to determine the daily compressive strength of concrete for twenty-eight days. The specific objectives of the study were to prepare three sets of samples consisting of twenty-eight concrete cylinders for each set, test the concrete samples for their daily compressive strength from day 1 to day 28, and to prepare a chart showing the age in number of days versus the daily percentage compressive strength.*

*A typical concrete mixture was made using proper proportioning of materials (including water) for a given strength, within general limits imposed by the cement content and workability. Three batches of concrete mixtures were prepared, each having a different water-cement ratio of 0.85, 0.8 and 0.65. Consistency was carefully checked to prevent the bleeding of concrete. After the concrete was thoroughly mixed, the mixtures were poured into 28 cylindrical concrete molds having 6 inches diameter and 12 inches height. Proper procedure for placing concrete into these molds was strictly followed. The concrete mixtures were allowed to stay in these cylindrical molds overnight before curing. Using the Universal Testing Machine, samples were tested daily for their compressive strengths.*

*Results of the research conducted showed that concrete gained 27.11 percent, 58.10 percent, 76.22 percent, 89.34 percent, and 100 percent of its strength on the 1st, 7th, 14th, 21st, and 28th day, respectively. These results indicate discrepancies in the values from the study of Winter and Nelson (1980) where concrete has attained approximately 30 percent of its required strength on the first day, 70 percent on 7th day, 90 percent on 14th day, 95 percent on 21st day, and 100 percent on the 28th day.*

*The discrepancies could be due to the quality of materials used in the concrete mix, water-cement ratio, and variations in handling, transporting, placing and compacting procedures adopted.*

# INTRODUCTION

## *Background and Rationale*

People are usually asking whether concrete samples possess the strength required in the design. These inquiries are only answered after twenty-eight days, where samples are usually tested for their compressive strength or when compression tests are made exactly on the seventh or fourteenth day.

It is on the seventh, fourteenth and twenty-eighth day that the percentage strengths are available from existing charts. However, even if the test is not done on the seventh, fourteenth or twenty-eighth day, interpretation by interpolating values in the chart can be done although it may not be accurate. Furthermore, most contractors do not also have this chart for use. If the twenty-eight days-percentage strength chart is available, results of the test can be easily evaluated for its specified design strength. This chart will therefore, help practicing civil engineers in determining whether their concrete samples passed the required design strength. Through this chart, the percentage of the compressive strength will be known from day one up to twenty-eight day.

## *Objectives*

This study was conducted primarily to determine the daily compressive strength of concrete for twenty-eight days. The study further aimed to prepare three sets of samples consisting of twenty-eight concrete cylinders for each set, test the concrete samples for their daily compressive strength from day 1 to day 28, and to prepare a chart showing the age in number of days versus the daily percentage compressive strength.

## MATERIALS AND PROCESS OF TESTING

### *Materials for the Concrete Mixture*

Type 1 Portland cement belonging to Type 1, or cement for general construction was used in this research. This cement has a fineness passing sieve No. 200. No particular brand of cement was used as long as it conforms to the American Society for Testing and Materials (ASTM) requirements.

Only potable and clean water was used in the mixing of concrete. Water containing alkalis, salts, silt, and organic matter was strongly avoided.

Coarse aggregates having a diameter of 3/8 inch to 1 inch and fine aggregates passing through the sieve were used. Both of these aggregates used in the concrete mix were tough, hard, strong, durable, of proper gradation, free from organic matter and non-reactive with cement. These aggregates conform to ASTM specifications.

### *Manufacture of Concrete Samples*

A typical concrete mixture was made using proper proportioning of materials (including water) for a given strength and within general limits imposed by the cement content and workability. The method used for proper proportioning of the materials was Method 1, which uses arbitrary proportions of cement, sand and course aggregates without any preliminary test. Method 1 involves proportioning concrete mixes by means of their masses or sometimes by their volumes. In this study, the proportions were based on mass.

Three batches of concrete mixtures were prepared each having a different water-cement ratio of 0.85, 0.80 and 0.65. Consistency was carefully checked to prevent the bleeding of concrete. After the concrete was thoroughly mixed, the mixtures were poured into 28 cylindrical concrete molds. Each cylindrical concrete mold is 6 inches in diameter and 12 inches in height. Proper procedure for placing concrete into molds was strictly followed. The concrete mixtures were allowed to stay in these cylindrical molds overnight before curing.

### *Curing*

The hardened concrete samples were removed from the cylindrical molds and then placed inside a curing tank with an average water temperature that ranged from $20^0$ C to $30^0$ C. The samples were cured for 28 days.

### *Testing*

Concrete samples were taken out from the curing tank and were allowed to dry for about three hours before capping with sulfur. The concrete samples were tested daily for their compressive strengths using the Universal Testing Machine. The compressive strengths for each batch of concrete mixture were recorded daily from the first day it was made until the twenty-eighth day.

## RESULTS AND DISCUSSION

### *Average Compressive Strength*

The average compressive strength of the three batches of concrete samples is shown in Table 1. Results of the research conducted showed that concrete gained 29.65 percent, 57.35 percent, 70.82 percent, 81.75 percent, and 100 percent of its strength on the $1^{st}$, $7^{th}$, $14^{th}$, $21^{st}$, and $28^{th}$ day, respectively.

**Table 1. A verage Percentage Attainment of the Daily Compressive Strength of the Three Batches of Concrete Samples**

| Age | Compressive Strength | Age | Compressive Strength |
|---|---|---|---|
| -days- | -percent- | -days- | -percent- |
| 1 | 29.65 | 15 | 71.45 |
| 2 | 41.08 | 16 | 73.91 |
| 3 | 41.51 | 17 | 75.05 |
| 4 | 48.92 | 18 | 76.11 |
| 5 | 50.40 | 19 | 78.44 |
| 6 | 53.58 | 20 | 79.33 |
| 7 | 57.35 | 21 | 81.75 |
| 8 | 58.41 | 22 | 86.19 |
| 9 | 58.87 | 23 | 89.88 |
| 10 | 66.20 | 24 | 90.30 |
| 11 | 68.49 | 25 | 90.30 |
| 12 | 69.34 | 26 | 92.21 |
| 13 | 70.67 | 27 | 97.34 |
| 14 | 70.82 | 28 | 100.00 |

### *Adjusted Daily Compressive Strength*

The values of average daily compressive strength percentages were adjusted such that on the 28th day concrete has attained it full strength. The computer software Microsoft Excel was used to compute the adjusted values and to plot the age versus the computed average of three trials. The result was then used to establish the trend line of the actual average. The equation: $Y = 27.11x\ 0.3917$ best fits the curve and was therefore utilized to compute the adjusted daily average compressive strength. The adjusted daily average compressive strength was established to come up with a standardized chart for determining compressive strength of concrete. Figure 1 shows the average and the adjusted daily compressive strength percentage trend line.

As shown in Table 2, concrete samples gained 27.11 percent, 58.10 percent, 76.22 percent, 89.34 percent, and 100 percent of their strength on the 1st, 7th, 14th, 21st, and 28th day, respectively. These results indicate discrepancies in the values from the study of Winter and Nelson (1980) where concrete has attained approximately 30 percent of its required strength in day one, 70 percent on the 7th day, 90 percent on the 14th day, 95 percent on 21st day, and 100 percent on the 28th day.

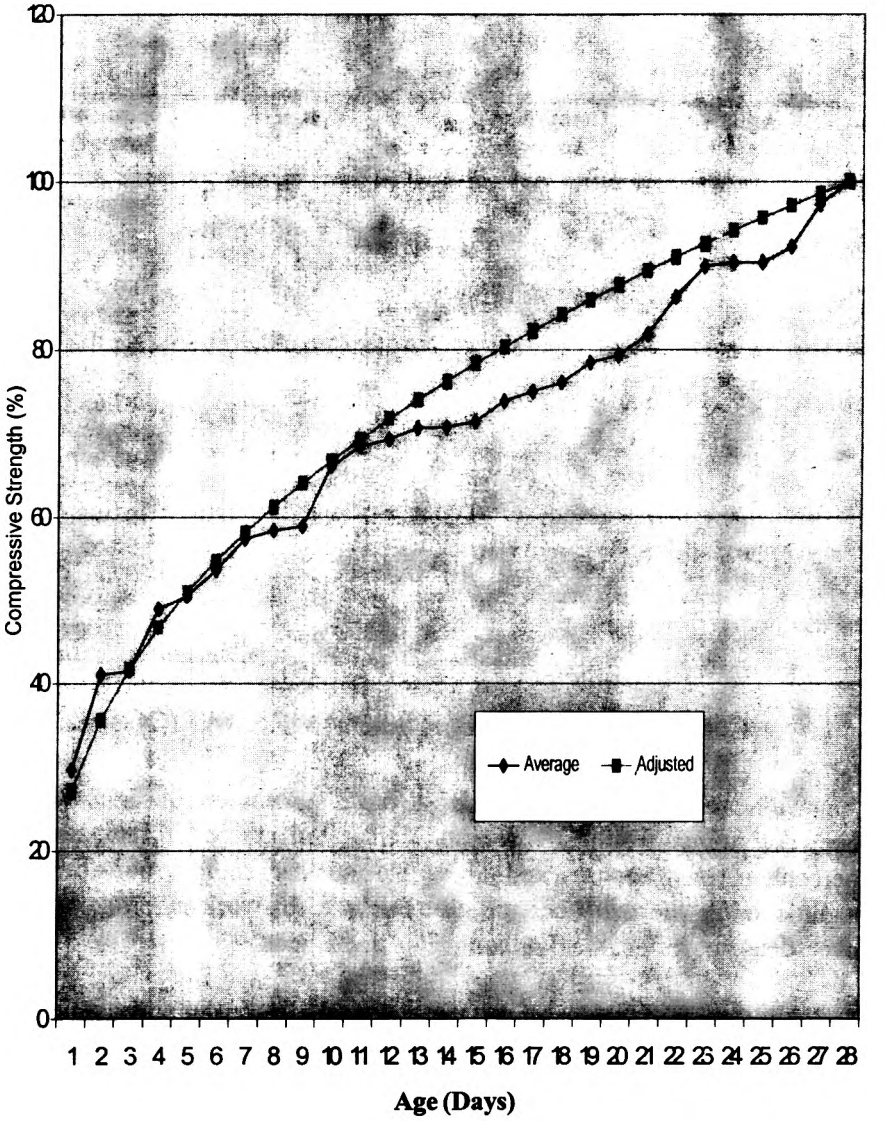


**Figure 1. Average and Adjusted Daily Compressive Strength**

**Table 2. Adjusted Percentage Attainment of the Daily Compressive Strength**

| Age | Compressive Strength | Age | Compressive Strength |
|---|---|---|---|
| -days- | -percent- | -days- | -percent- |
| 1 | 27.11 | 15 | 78.31 |
| 2 | 35.57 | 16 | 80.31 |
| 3 | 41.69 | 17 | 82.24 |
| 4 | 46.66 | 18 | 84.10 |
| 5 | 50.92 | 19 | 85.90 |
| 6 | 54.69 | 20 | 87.65 |
| 7 | 58.10 | 21 | 89.34 |
| 8 | 61.22 | 22 | 90.98 |
| 9 | 64.11 | 23 | 92.58 |
| 10 | 66.81 | 24 | 94.14 |
| 11 | 69.35 | 25 | 95.65 |
| 12 | 71.75 | 26 | 97.31 |
| 13 | 74.04 | 27 | 98.58 |
| 14 | 76.22 | 28 | 100.00 |

## CONCLUSION AND RECOMMENDATIONS

Values of the daily compressive strength percentages of concrete have been determined from this research. A chart and a table for these strength percentages have been created. This table and chart could be considered as a guide for on-site or field conditions. The research work undertaken, however, does not reflect ideal or controlled conditions.

It is therefore recommended that a research of similar purpose be conducted in controlled conditions. Materials used for concrete mixtures must be tested and proper handling procedures must be strictly followed.

Another recommendation is to do a research on the comparison of compressive strength between cured and non-cured concrete specimens.

## REFERENCES

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