International Journal of Scientific Research in Modern Science and Technology
ISSN: 2583 -7605 (Online)
© IJSRMST \ Vol. 2 \ Issue 3 \ 2023
Available online at: www.ijsrmst.com

# STRENGTH PROPERTIES ON FOAMED CONCRETE

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**ABSTRACT:**

In order to cut down on building weight and expense, speed up the construction process, and make handling of precast segment easier, partition wall applications are suitable for the foamed concrete constructions. Compressive strength of foamed concrete of varying water cement ratio has been investigated. Compressive strength and split tensile strength is correlated in this paper's experimental study of strength properties on foamed concrete with a density of 1200 kg/m$^3$. At the age of 7 days and 28 days the compressive strength was measured and for 28 days the split tensile strength was measured in 66 foamed concrete cubes of varying densities and water-cement ratios. The spread value of the inverted slump and flow table was calculated. The greatest compressive strength of 9.2 MPa and split tensile strength of 3.4 MPa were reported in experiments conducted at a density of 1200 kg/m$^3$ andfor the w/c ratio of 0.5. In this study, we tested foamed concrete with the usage of slag materials variation and w/c ratio of 0.4 and 0.5 respectively to measure its compressive strength and split tensile strength. Steel slag is used in place of sand, and the amounts used depend on the context.

**Keywords:** Foam Concrete, lightweight concrete, compressive strength and density.

## 1. Introduction:

In building, the self-weight of concrete contributes significantly to the total dead load. Foamed concrete is a type of lightweight, cellular concrete that is created by either adding prepared foams to a new concrete mixture or by creating bubbles within the mixture itself. Using lightweight concrete has many benefits, including lowering a building's overall weight. Foamed concrete typically has a density between 300 and 1800 kg/m$^3$. The density of foamed concrete can be lowered by increasing the number of foams used in the mixture. Foamed concrete's main benefit is that it can replace heavy foundation systems with lighter ones, and that it doesn't require compaction because it doesn't settle and spreads out to fill any gaps it encounters on its own. Foamed concrete's use negated the need for concrete vibration or compaction, decreased labour requirements, and accelerated the building process. Foamed concrete's compressive strength looked to decline as foam volume increased. This is because foamed concrete has a lower density than regular concrete since the foaming chemical introduces air bubbles into the mortar mix. Too much air void in the foamed concrete, however, could make it more porous and prone to breaking and failing underweight. The increased void content of lightweight foamed concrete reduces the material's strength. As a result, it is less ideal for structural applications. The effectiveness of lightweight foamed concrete of varying concrete densities is tested experimentally. Strengthening foamed concrete for structural use requires the creation of a new mixture design. Lightweight foamed concrete with densities of 200, 400, 600, 800, 1000, and 1200 kg/m$^3$ is the primary focus of this investigation. Ordinary Portland Cement (OPC), sand, steel slag, water, and a foaming ingredient are used to make foamed concrete for this experiment.

## 2. METHODS AND MATERIAL

### Mix proportions

In this research, foamed concrete was made utilising the pre-foaming method, in which the mortar mix with the prefoaming technology parallel the slurry were made independently and mixed as a foamed concrete. Dry foam, made by forcibly evaporating the foaming agent solution, was utilised. The foam generator used a mixture of foaming agent and water ratio is 1:30 was applied in this work. Table 1 shows the relative amounts of steel slag to sand in the foamed concrete mix with other ingredients.

**Table 1. Mix Proportion of Foamed concrete**

| Mix ID | w/c ratio | Cement (kg/m$^3$) | Sand (kg/m$^3$) | Steel Slag (kg/m$^3$) | Water (kg/m$^3$) | Foaming Agent (kg/m$^3$) |
|---|---|---|---|---|---|---|
| FC | 0.4 | 650 | 650 | 0 | 256 | 12.3 |
| FC1 | 0.4 | 650 | 568 | 82 | 256 | 12.3 |
| FC2 | 0.4 | 650 | 585 | 65 | 256 | 12.3 |
| FC3 | 0.4 | 650 | 552 | 98 | 256 | 12.3 |
| FC4 | 0.4 | 650 | 520 | 130 | 256 | 12.3 |
| FC5 | 0.4 | 650 | 488 | 162 | 256 | 12.3 |
| FC6 | 0.5 | 650 | 650 | 0 | 256 | 12.3 |
| FC7 | 0.5 | 650 | 568 | 82 | 256 | 12.3 |
| FC8 | 0.5 | 650 | 585 | 65 | 256 | 12.3 |
| FC9 | 0.5 | 650 | 552 | 98 | 256 | 12.3 |
| FC10 | 0.5 | 650 | 520 | 130 | 256 | 12.3 |
| FC11 | 0.5 | 650 | 488 | 162 | 256 | 12.3 |

The density of the base mix and the desired density both have an effect on the volume of foam that is required. Throughout the course of this investigation, the amount of super-plasticizer used and the proportion of water to cement were changed in order to achieve an identical level of base mix flowability. Because of the significant disparity between the specific gravities of sand and steel slag, the density of the base mix is mostly determined by the extent of replacement using steel slag.

### Testing methods

The inverted slump test, compression strength, and split tensile were some of the testing methods that were utilised for this investigation. For the purpose of determining how easily foamed concrete may be worked, an inverted slump test was carried out.

## 3. RESULTS AND DISCUSSION

### Slump Test

The findings of the inverted slump test are presented in Table 2. It was discovered that increasing the volume of the foam concrete mis has a negative effect as shown in Table 2.

**Table 2. Workability Test (Slump Test)**

| Mix ID | Slump Value(mm) |
|---|---|
| FC | 604 |
| FC1 | 625 |
| FC2 | 632 |
| FC3 | 640 |
| FC4 | 632 |
| FC5 | 586 |
| FC6 | 618 |
| FC7 | 623 |
| FC8 | 627 |
| FC9 | 632 |
| FC10 | 614 |
| FC11 | 607 |

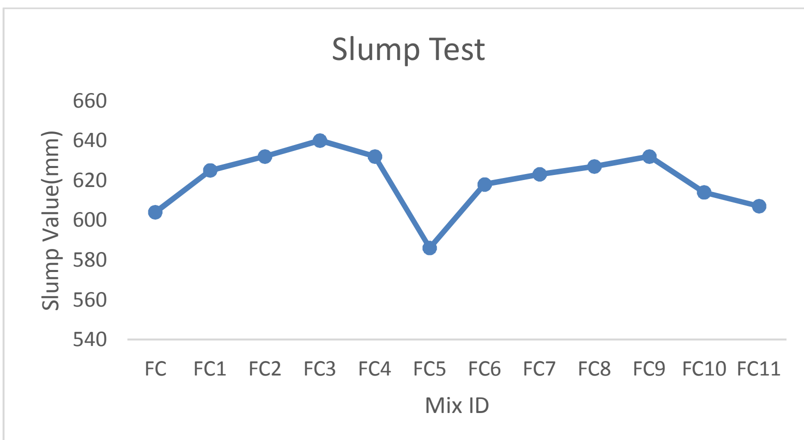



**Figure 1. Workability Test**

### Compressive strength

Compressive strength tests were conducted, and the results are summarised in Table 2. In this study, the effect of steel slag plays an important role in order to focus on determining the relation between the compressive strength and split tensile strength. The comparable strength at any density between 1200 kg/m$^3$ can be estimated based on the relationship between the two quantities.

With a water-to-cement ratio of 0.5 for 1200 kg/m$^3$ and compressive strengths ranging from 3.8 to 5.6 MPa after 7 days and 4.7 to 9.2 MPa after 28 days, the concrete will be ready for use. According to the findings, a water-to-cement ratio of 0.5 is preferable to be employed in the creation of base mix for LFC since it led to the achievement of the highest compressive strength. There was an obvious linear relationship between the hardened density and compressed strength, with compressive strength decreasing with an increase in steel slag replacement level. This was the case because the corresponding compressive strength shows an approximate linear transformation.

**Table 2. Test results on compressive strength**

| Mix ID | Compressive Strength (MPa) | |
|---|---|---|
| | 7 Days | 28 Days |
| FC | 3.8 | 4.7 |
| FC1 | 3.9 | 5.8 |
| FC2 | 4.2 | 6.2 |
| FC3 | 4.6 | 8.3 |
| FC4 | 4.1 | 7.4 |
| FC5 | 3.6 | 7.1 |
| FC6 | 4.2 | 6.8 |
| FC7 | 4.6 | 7.9 |
| FC8 | 4.9 | 8.6 |
| FC9 | 5.6 | 9.2 |
| FC10 | 5.3 | 8.7 |
| FC11 | 4.8 | 7.3 |

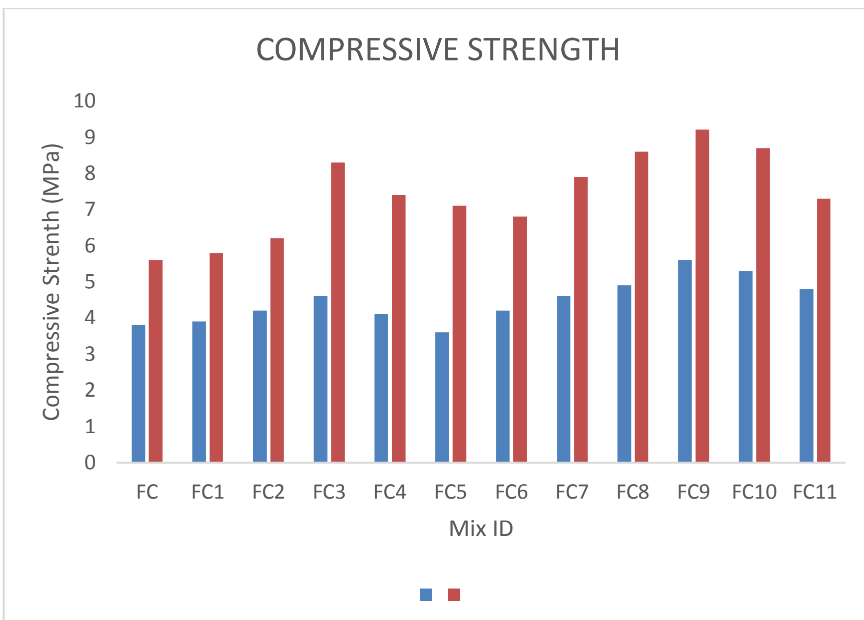



**Figure 2. Test results on compressive strength**

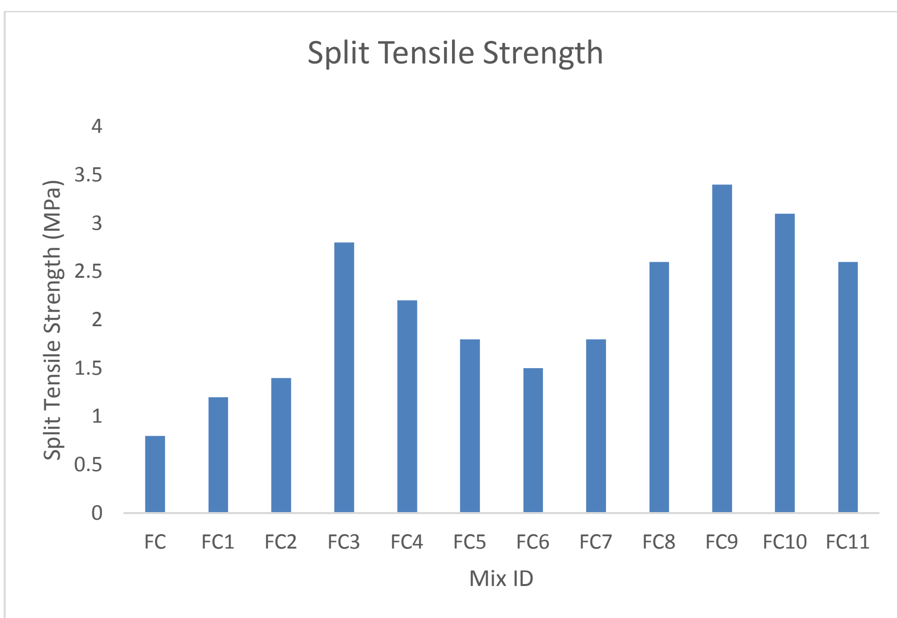
The earlier studies that demonstrate an increase in strength could have different gradations for sand and steel slag, with steel slag perhaps having a bigger fineness modulus and a lower specific gravity than sand. A certain quantity of fine steel slag can, without a shadow of a doubt, improve the strength of concrete; nevertheless, this improvement was insufficient to compensate for the decrease in strength that was caused by the increase in foam volume that was caused by the high specific gravity of the steel slag that was employed.

## Split Tensile Strength

Table 4 presents the results of tests and analyses conducted on the split tensile strength. Additionally, it was observable that the attained hardened density had an effect on the split tensile strength as well as the performance index. As a result the researchers came to the conclusion that, just as the compressive strength, the split tensile strength decreased practically linearly as the level of steel slag replacement.

**Table 2. Test results on split tensile strength**

| Mix ID | Split Tensile Strength (MPa) |
|---|---|
| FC | 0.8 |
| FC1 | 1.2 |
| FC2 | 1.4 |
| FC3 | 2.8 |
| FC4 | 2.2 |
| FC5 | 1.8 |
| FC6 | 1.5 |
| FC7 | 1.8 |
| FC8 | 2.6 |
| FC9 | 3.4 |
| FC10 | 3.1 |
| FC11 | 2.6 |




**Graph 3. Test results on split tensile strength**

## 4. CONCLUSION

The levels of replacement ranged from 0% to 25%, and the replacement levels were as follows: 5%, 10%, 15%, 20%, and 25%. The findings indicate that the compressive strength and split tensile were decreased practically linearly with the increase in replacement level; however, this trend was reversed with a replacement level of 15% and a density of 1200 kg/m$^3$. The results of the experiments showed that the highest compressive strength, which was recorded as 9.2 MPa, was achieved with a density of 1200 kg/m$^3$ and a water cement ratio of 0.5. Additionally, the highest split tensile strength, which was achieved, was 3.4 MPa.

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**Cite this Article**

**A. Dhanalakshmi, Dr. M. Shahul Hameed, P. Aarthi, J. Jeyaseela, "STRENGTH PROPERTIES ON FOAMED CONCRETE",** International *Journal of Scientific Research in Modern Science and Technology (IJSRMST),* ***ISSN:*** *2583-7605 (Online), Volume 2, Issue 3, pp. 22-27, March 2023.*

***Journal URL:*** https://ijsrmst.com/