

## FRESH AND HARDENED CONCRETE COMBINED WITH LIME STONE FINES AS A SUBSTITUTION FOR CEMENT

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### Abstract

*Cement manufacture emits substantial quantities of carbon dioxide, significantly affecting the climate, while also necessitating considerable energy use. Moreover, the disposal and recycling of conventional concrete constituents may result in environmental deterioration. Utilizing trash in concrete decreases both making cement and utilization of energy. This research aims to assess the characteristics of fresh and hardened concrete by partly substituting cement with limestone fines (LSF). This research included substituting cement with LSF at proportions of 0%, 5%, 10%, 15%, and 20% by weight of cement. The entirety of 30 samples of concrete was prepared using a mix ratio of 1:1.5:3. Cube-sized specimen was evaluated for compressive strength, and density of concrete at 28 days, correspondingly. The optimal result indicated that the compressive strength enhanced by 10.75% when 10% LSF was used as a cement replacement in concrete after 28 days. The slump value and density of concrete decreased with an increase in LSF concentration.*

## 1. Introduction

Concrete, a man-made substance, is widely employed in civil engineering projects [1-3]. Portland Cement (PC) is widely utilized in structural uses and is suitable for most building projects. Nevertheless, its shortcomings make it challenging to meet some needs, particularly for complicated constructions that demand strength and longevity. The demand for superior performance concrete has grown to satisfy highly complex and difficult structural specifications [4]. Creating high-strength concrete (HSC) needs a significant volume of cement.

Cement manufacture is regarded as a particularly energy-intensive element in making concrete [5]. Cement manufacture emits significant amounts of CO<sub>2</sub>, causing environmental concerns. Roughly one ton of CO<sub>2</sub> is discharged into the atmosphere during the manufacture of OPC cement. Cement manufacture accounts for 5-7% of CO<sub>2</sub> emissions from manufacturing processes [6]. To minimize CO<sub>2</sub> emissions and promote sustainability in real estate development, it is necessary to limit the usage of PC without impairing concrete building performance [7-9]. Using a mix of cement-based replacement substances may be cost-effective and improve mechanical and microstructural properties, which can lead to enhanced durability and reduced environmental impact in concrete applications [10]. CRMs, or cement replacement materials, are increasingly being used in concrete constructions to extend their service life. These components are widely accessible and may be utilized in concrete [11]. Regular supplies used include sugarcane bagasse ash (SCBA) [12, 13], limestone fines (LSF), rice husk ash (RHA) [14-16], and silica fume (SF) [17, 18]. This study examined the impact of using LSF as a cement substitute substance in concrete.

LSF may be utilized as cement, a substance or fine aggregates in concrete mix [19, 20]. A number of studies have examined the strength production of concrete incorporating LSF. In [21], the researchers investigated how LSF

concentration affects the compressive strength and longevity of concrete. They observed that raising the quantity of LSF in concrete improves strength while decreasing porosity. LSF concrete with a 0.40w/b ratio outperformed 0.50 and 0.60w/b ratios in terms of strength development. Concrete's permeability and pore size dropped considerably after 28 days. According to [22], the use of LSF in concrete improves crushing strength, as well as permeability. The key purpose of this investigation is to measure the slump test, density and compressive strength of concrete comprising with several dosages of LSF and to make it sustainable concrete.

## 2. Experimental Program

### 2.1. Materials

The LSF were purchased from the local market. Subsequent to collection, the materials were subjected to sieving via 75-micron sieves to achieve a fine powder consistency, which was subsequently used as a cementitious component in concrete mixtures. Furthermore, cement served as the binding agent in the mixture. Hill sand, which passed through #4 mesh sieves, was employed as fine aggregates, while crushed stones with a size of 20 mm served as coarse aggregates. The aggregates were sourced locally from the market. The potable water was applied for the preparation and curing process of concrete.

### 2.2. Research Methodology

The investigation study aims to evaluate the fresh and hardening characteristics of concrete through the addition of 0% to 20% of LSF as a substitute for cement in the mix. Thirty concrete specimens with a mix ratio of 1:1.5:3 were created, using a water/cement ratio of 0.45, and were cured for a duration of 28 days. This mix proportions quantity is given in Table 1. Moreover, the concrete specimens were evaluated using a Universal Testing Machine (UTM). This research included the casting and testing of concrete cubes (100mm×100mm×100mm) for compressive strength and density. For every proportion, three concrete specimens were made, and the average of these specimens was deemed the final outcome.

**Table 1:** *Mix Design Concrete*

Mix Design	Binding Components (%)		Quantity of Concrete Constituents are needed to make 1 m <sup>3</sup> Concrete (kg)				
	PC	LSF	Cement	LSF	CA	FA	Water
LSF0	100	0	345	0	1035	518	156

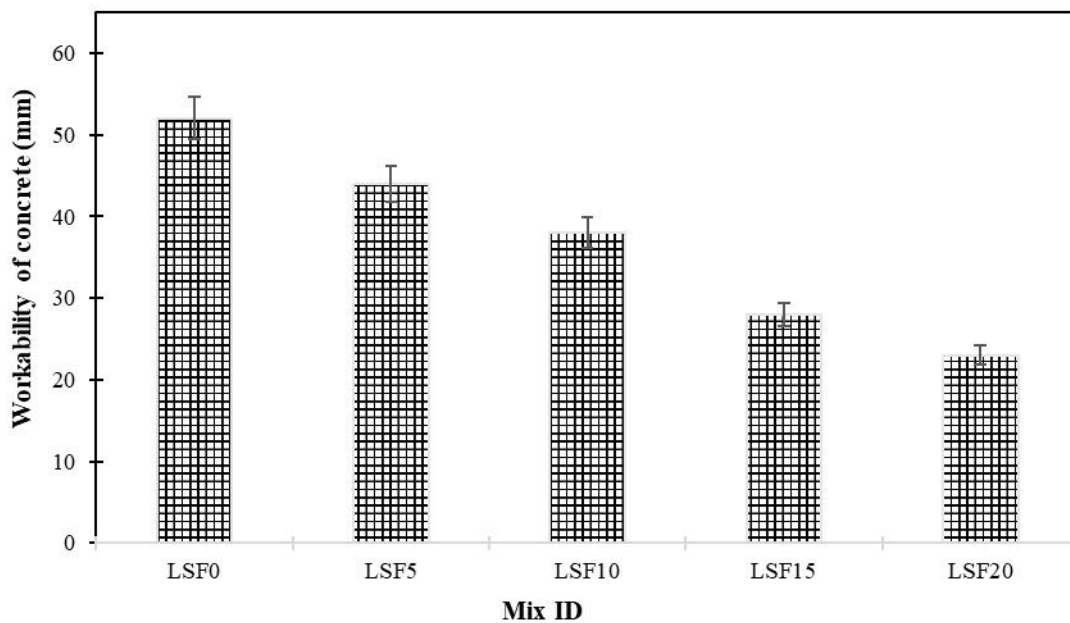
LSF5	95	5	327.75	17.25	1035	518	156
LSF10	90	10	310.5	34.5	1035	518	156
LSF15	85	15	293.25	51.75	1035	518	156
LSF20	80	20	276	69	1035	518	156

**3.RESULTS AND DISCUSSION**

**3.1.Slump Test**

Figure 1 illustrates the evaluation undertaken to measure the uniformity of concrete with LSF as a supplemental cementitious ingredient. The best slump value for a controlled blend is 52 mm, while the minimum slump value recorded is 23 mm when using 20% LSF as a supplemental

cementitious additive. The implementation of LSF in the mixture appears to lessen the slump in a concrete mix. The performance reduction is due to the increased specific surface area of LSF particles compared to PC, that absorbs more water as the LSF fraction in the concrete mix rises.



*Figure 1: Workability of LSF Concrete*

**3.2.Dry Density**

Figure 2 illustrates the evaluation undertaken to measure the density of concrete with LSF as a supplemental cementitious ingredient after 28 days. Concrete density measured for 5%, 10%, 15%, and 20% LSF are 2350, 2308, 2288, and

2268 kg/m<sup>3</sup>, correspondingly, which are below the reference mix. The density dropped dramatically as the LSF dosages in the mixture increased. The drop in density caused by the specific gravity of LSF is smaller than that of cement.

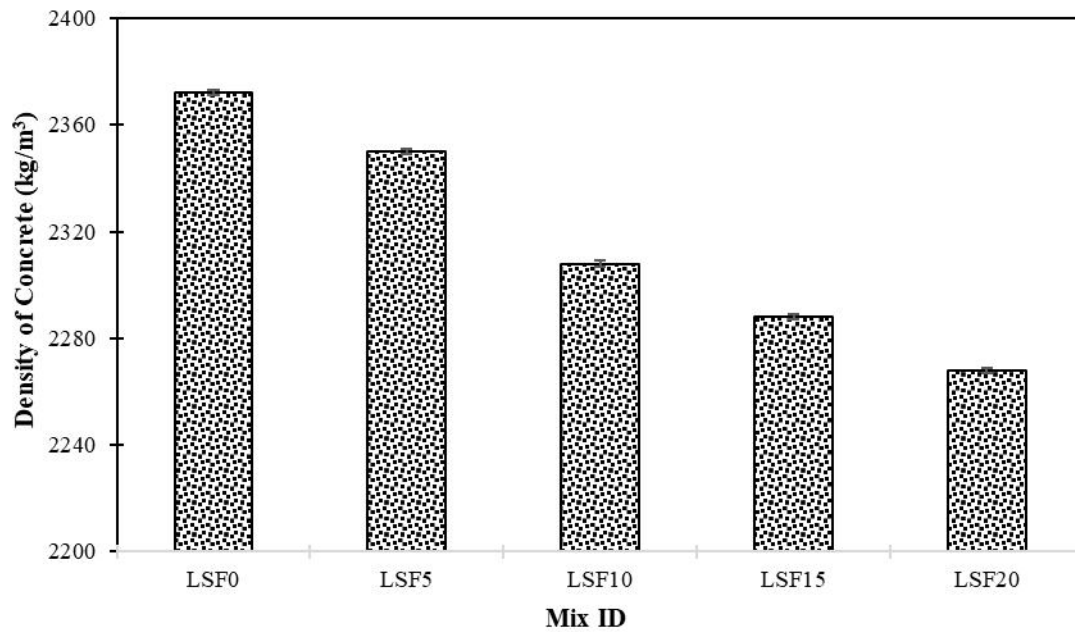


Figure 2: Dry Density of LSF Concrete

### 3.3. Compressive Strength

The assessment was performed on cubic samples made of concrete with LSF as a supplemental cementitious substance, as illustrated in Figure 3. The peak compressive strength is recorded at 33.78 MPa with 10% LSF, whereas the lowest strength is seen at 21.15 MPa with 20% LSF in concrete at 28 days. The findings from the experiment demonstrated that the strength of concrete increased with the addition of up to 10% LSF, due to the smaller particle size of LSF filling the pore sizes created by the different concrete components. Nevertheless, at this level, strength starts to drop owing to the dilutive impact of LSF on cement, thereby lowering the pozzolanic interconnections among the concrete constituents.

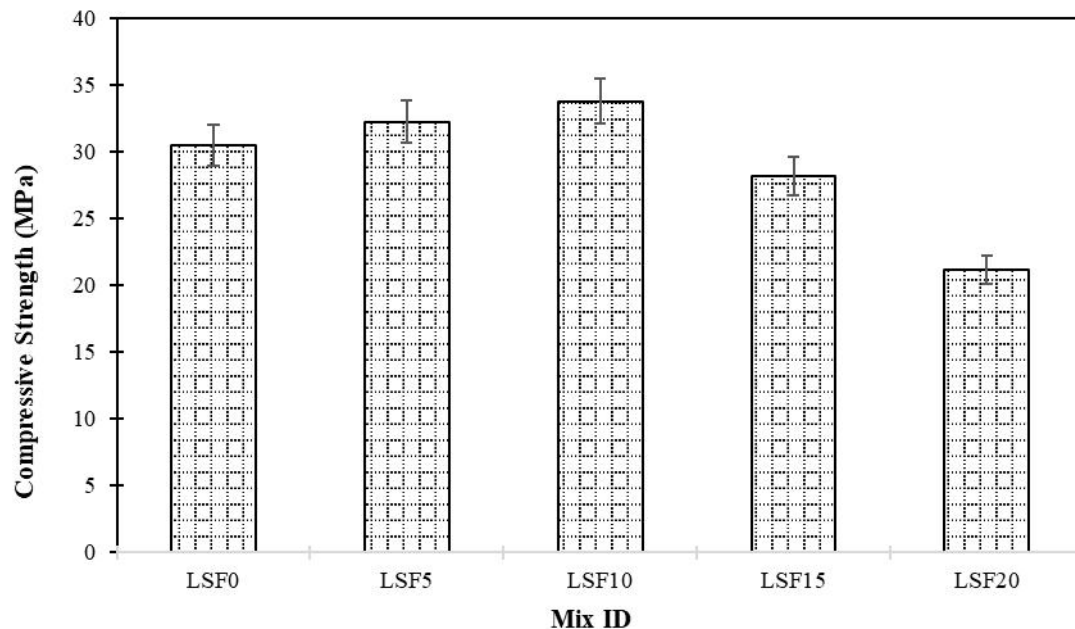


Figure 3: CS of LSF Concrete

### 4. Conclusions

The key points are drawn from the findings of the research as follows:

- The addition of LSF as SCM lowered slump levels in all of the samples when in comparison with the control mixture. The decrease in slump value is due to LSF's higher water absorption as a supplemental cementing substance in contrast to PC.

- The density dropped dramatically as the LSF dosages in the mixture increased. The drop in density caused by the specific gravity of LSF is smaller than that of cement.
- The peak compressive strength is recorded at 33.78 MPa with 10% LSF, whereas the lowest strength is seen at 21.15 MPa with 20% LSF in concrete at 28 days. The findings from the experiment demonstrated that the strength of concrete increased with the addition of up to 10% LSF, due to the smaller particle size of LSF filling the pore sizes created by the different concrete components.
- The test results show that 10% LSF gives the highest strength and is recommended for usage in building.

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