anda d sand

Table 4: Fresh concrete test results for standard sand

Mix	Slump value (mm)	Inference	Flow (cm)	Compaction factor (%)
M1	140	Highly workable	44.67	81.97
M2	160	Highly workable	46.73	95.36
M3	170	Highly workable	48.5	97.45

In contradiction to Msand, it was observed that standard sand has an increase in flowability with an increase in the percentage of fly ash due to the particle size of grade 1 standard sand (1mm to 2mm) which is relatively coarser when compared to Msand. As the particle size increases the flowability of concrete gradually increases which is inferred from Figure 2 and Figure 3. The fine particles in the sand, coupled with the reactive characteristics of fly ash, likely contribute to improved particle packing and lubrication within the mixture. This combination enhances the flowability and workability of the concrete.

The fine particles in the grade 1 standard sand may interact with the fly ash, resulting in better dispersion and bonding, which could explain the increase in slump and flow values. The increasing trend in slump value also aligns with the notion that fly ash, as a fine and pozzolanic material, could lead to improved particle packing and lubrication within the mixture, promoting better workability. The rising flow values imply that higher amounts of fly ash could potentially enhance the fluidity and self-levelling properties of the concrete, making it more suitable for applications requiring intricate Mold-filling or complex formwork.

In addressing the challenge of lower compaction factors associated with uniformly graded aggregates, this study explores the potential of mitigating this limitation through the incorporation of fly ash in concrete mixtures. Utilizing the results from M1, characterized by a comparatively lower compaction factor, we consider the impact of increased fly ash percentages. Given the proven benefits of fly ash, such as its pozzolanic properties and ball-bearing effects, an augmentation in fly ash content is examined to enhance lubrication during compaction. The findings from M2 and M3, which exhibit higher compaction factors as in Table 4, support the notion that an elevated fly ash percentage can contribute positively to compaction characteristics. This suggests optimizing uniformly graded aggregates in concrete mixes, demonstrating the technical feasibility of adjusting fly ash proportions to overcome challenges associated with compaction and improve overall workability. Careful consideration of the balance between fly ash content and other mix constituents is crucial to achieving optimal concrete performance.

5. Hardened Concrete test

5.1 Compressive strength and split tensile strength

Table 5. Hardened concrete test results for M sand.

Mix	Compressive strength (N/mm^2)		Split tensile strength (N/mm^2)	
	Msand	Standard sand	Msand	Standard sand
M1	16.67	18.5	2.1	2.26
M2	17.97	16.35	1.66	2.89
M3	17.13	17.93	1.84	2.41

It was observed that there was a gradual increase in compressive strength with its peak at 40% of fly ash for the Msand mix as in Figure 4. Inferring from the graph Figure 4, an optimum replacement level was found in a 40% fly ash mix. Further increase in fly ash content increases the porosity in the concrete leading to a decrease in compressive strength of the concrete. The compressibility trends as seen in Table 5, suggest that different fine aggregates respond uniquely to varying levels of fly ash content, potentially due to particle size distribution, shape, and interaction effects. There is a consistent decrease in split tensile strength for Msand as the mix percentage increases [1] as in Figure 6. Interestingly, Standard sand exhibits a more erratic trend, with a significant drop at 40% mix as seen in Figure 5. These findings shed light on the nuanced influence of sand proportions on concrete's split tensile strength, providing valuable insights for mix design considerations in construction practices.

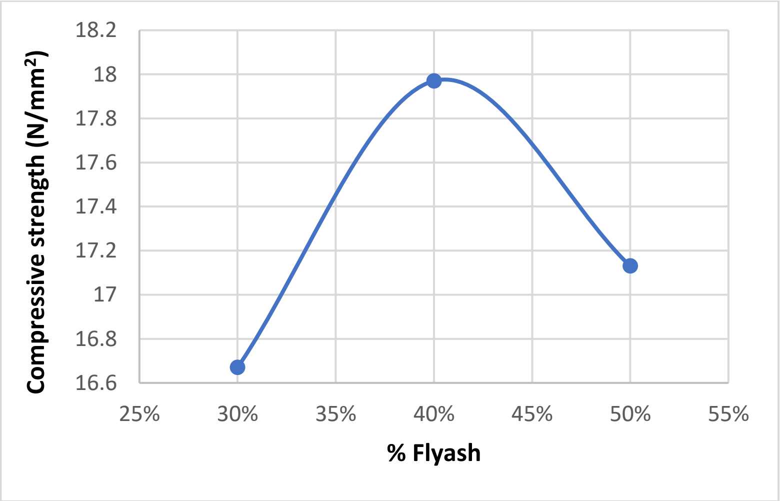

Figure 4. Relation Between Fly Ash Content with Compressibility Using Msand

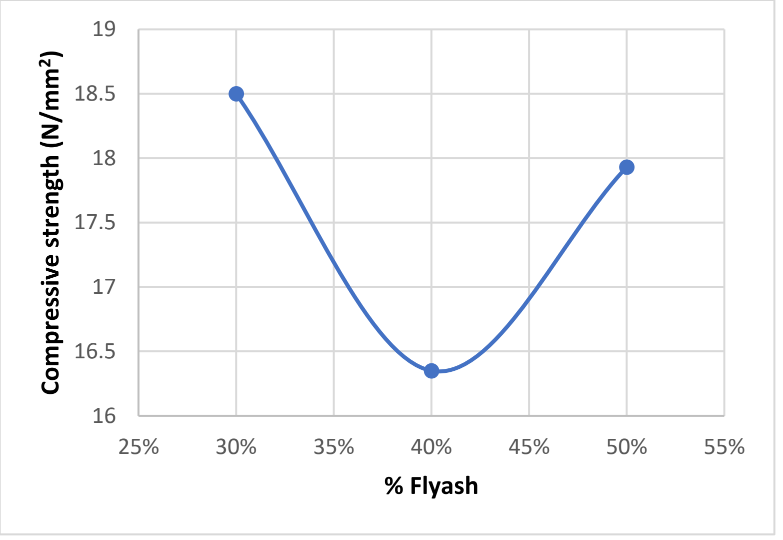

Figure 5. Relation Between Fly Ash Content with Compressibility Using Standard Sand

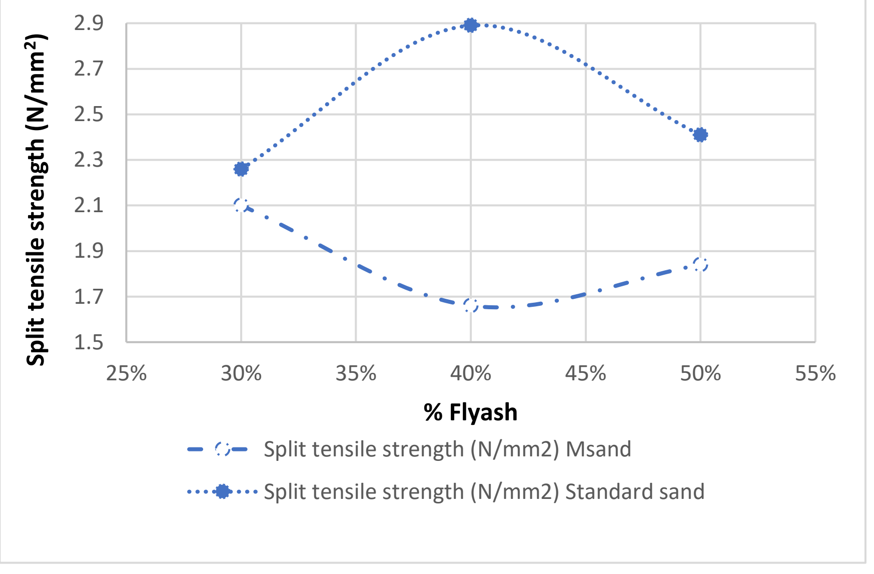

Figure 6. Relation Between Fly Ash Content with Split Tensile Strength for Msand and Standard Sand

6. Density

Table 6. Hardened Concrete Test Results for Standard Sand

Mix	Density (kg/m³)	
	Standard sand	Msand
M1	2573	2516
M2	2647	2596
M3	2530	2590

At 30% fly ash, the highest density of 2573 kg/m³ as in Table 6 and Figure 7 could indicate an optimal balance between the finer fly ash particles and the standard sand particles. However, a slight decrease in density at 50% fly ash (2530 kg/m³) might be attributed to the dominance of the lighter fly ash particles, impacting the overall mixture density. Higher density in standard sand can lead to a higher overall weight of the concrete mix, potentially making it more suitable for specific applications where greater mass is desirable.

In contrast, m-sand mixtures show a different trend. The density is lowest at 30% fly ash (2516 kg/m³) as in Figure 7, possibly due to interactions between m-sand and fly ash particles resulting in a less compact arrangement. As the fly ash content increases to 40%, the density rises (2596 kg/m³), indicating that the addition of fly ash is starting to improve particle packing within the m-sand mixture. At 50% fly ash, the density remains relatively stable (2590 kg/m³), suggesting a balance between the effects of increased fly ash content and the inherent characteristics of m-sand. M sand's lower density might be advantageous in terms of reducing the overall weight of the concrete mix, which can be beneficial in situations where lighter structures are desired, or when constructing elements like precast panels.

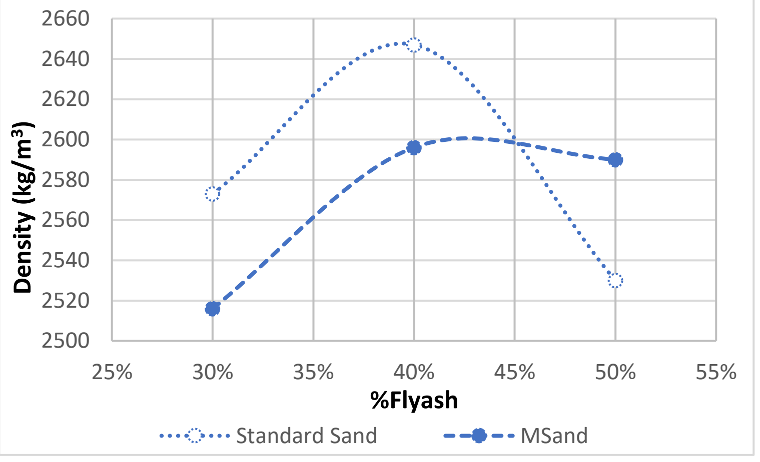

Figure 7. Comparison of Concrete Density for Msand and Standard Sand with Fly Ash Content

7. Conclusion

The 40% fly ash mix in both Msand and standard sand shows favourable results in terms of workability and strength. The 50% fly ash mix also exhibits good workability, but its compressive strength is lower than the 40% mix. The use of standard sand results in slightly higher compressive strength values compared to Msand for the same fly ash percentage (e.g., 40% fly ash mix). For $1m^3$ concreting around 700kg of fine aggregate is required which costs about Rs 81,900 for standard sand and Rs 44,100 for Msand which is half the amount required by standard sand. Hence the use of Msand in construction can considerably be cost effective.

The 30% fly ash mix generally shows high workability but lower density, which may be suitable for certain applications. When we replace 30% of cement with fly ash, it's considered a moderate replacement. This mix maintains good early strength and can be suitable for various applications, including structural elements like beams and columns aligning with previous findings [2]. Using a lower percentage of fly ash 30% is common in pile foundations to ensure the necessary strength is achieved. This helps maintain early and long-term strength. The 40% fly ash mix demonstrates a good balance between workability, and density and retains its flowability for a maximum of 30 minutes giving additional time to work with the concrete. This percentage is often chosen for slabs where a balance between sustainability and workability is essential. Concrete with 40% fly ash replacement can still maintain good workability and flowability while reaping the environmental benefits of fly ash and, it's often preferred for non-structural elements like pavements and sidewalks due to its improved durability [1]. The 50% fly ash mix provides high workability but has lower density and compressive strength. This mix may have slightly reduced early strength but can still be used for structural elements with proper design considerations and can also be used in slabs with finishing and for some foundations like drilled piers [2]. However, it's often used in applications where long-term strength and sustainability are more critical than immediate strength.

The compatibility of superplasticizer with HVFA concrete emphasizes the impact of binder content on the dosage of high-range water-reducing admixture (HRWR). Adequate curing is crucial for optimal HVFA concrete performance. The relationship between total binder content and properties like strength development and pore size distribution is a shared focus, indicating that increasing the total binder content may not significantly benefit certain aspects of concrete performance [3].

Based on the comprehensive test results and graphical comparisons, the 40% fly ash mix with Msand emerges as a recommended choice. This composition presents a well-balanced compromise between workability and compressive strength [3]. The test outcomes and graphical analyses indicate that this blend offers promising characteristics that meet both the criteria of ease of handling during construction and structural strength. As a result, it stands out as an optimal option for applications where a balance between these two crucial factors is essential in concrete formulation.

8. References

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