IOCM 2025 Conference

The 4th International Online Conference on Materials

3–6 November 2025 | Online

MDPI

Utilization of Lithium Slag as a Supplementary Cementitious Material in Concrete

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INTRODUCTION & AIM

The production of ordinary Portland cement (OPC) is a major contributor to global CO_2 emissions, accounting for approximately 8% of anthropogenic carbon output. As the demand for sustainable infrastructure grows, attention has turned to supplementary cementitious materials (SCMs) that can partially replace cement while improving resource efficiency and reducing environmental impact.

Lithium slag (LS), a by-product of lithium extraction and refining, is one such underutilized material. Its fine particle size, glassy phases, and reactive oxides suggest potential pozzolanic behavior. However, limited research has been conducted on its use in structural concrete and its influence on fresh and hardened properties.

This study aims to:

1.Evaluate the feasibility of using lithium slag (LS) as a supplementary cementitious material (SCM) in concrete.

2.Investigate the effects of 10%, 20%, and 30% LS replacement levels on the workability and compressive strength of 35 MPa and 45 MPa concrete.

3.Assess the sustainability potential of LS utilization in reducing cement consumption and promoting industrial waste valorization.

METHOD

concrete mixes were prepared with lithium slag (LS) replacing ordinary Portland cement (OPC) at 10%, 20%, and 30% by mass. Two target strengths were designed: 35 MPa and 45 MPa.

•**Materials:**

•OPC, natural sand, crushed coarse aggregate, and LS (24% initial moisture, adjusted to dry weight).

•**Mixing & Casting:**

•All materials were dry-mixed, followed by addition of water to achieve uniform consistency.

•**Testing:**

- Workability: Measured by the slump test (ASTM C143).
- Compressive strength: Determined at 7 days on standard cubes according to ASTM C39.

RESULTS & DISCUSSION

Results and Discussion:

The experimental findings demonstrated clear effects of lithium slag (LS) incorporation on both the fresh and mechanical properties of concrete.

Workability:

A progressive decline in workability was observed with increasing LS replacement levels. In the 35 MPa concrete, the slump reduced from 68 mm (control) to 35 mm at 30 % LS, while similar behavior was recorded in the 45 MPa mix. The reduction is primarily attributed to the higher fineness, angular particle shape, and water absorption characteristics of LS, which increase internal friction and decrease the amount of free water available for flow.

Compressive Strength:

Early-age (7-day) compressive strength decreased with increasing LS dosage.

•35 MPa concrete: 27.2 MPa (control) → 18.2 MPa (30 % LS)

•45 MPa concrete: 38.3 MPa (control) → 28.9 MPa (30 % LS)

This reduction reflects the slower pozzolanic reactivity of LS compared to OPC at early stages of hydration. LS primarily acts as an inert filler initially, but its silica-rich composition suggests that secondary C–S–H formation could contribute to later-age strength gain, which will be explored in further work.

Sustainability Potential:

Substituting up to 30 % of cement with LS could significantly reduce CO_2 emissions associated with OPC production while valorizing an industrial by-product from lithium processing. The environmental benefits outweigh the short-term mechanical drawbacks, especially in applications where high early strength is not critical.

CONCLUSION

Lithium slag reduced workability and early strength but showed potential as a sustainable cement replacement.

Its use can lower CO_2 emissions and promote recycling of industrial waste in concrete production.

FUTURE WORK / REFERENCES

Future work will examine long-term strength, durability, and microstructural behavior of LS concrete.

Optimization of mix design and activation methods will also be explored to enhance LS reactivity and performance.