The Effect of Different Percentages of Slag and Fly Ash on Compressive Strength and Carbon Footprint of Lightweight Concrete

Enhancing Sustainability in Concrete Production

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Date: March 25, 2024

Introduction

- Lightweight concrete is a type of concrete that utilizes porous and lightweight aggregates, to reduce its overall weight while maintaining structural strength.
- Reducing Carbon Footprint
  - More Lightweight Concrete can be transported at once reducing the amount of truck needed to transport the bar
  - The Supplementary Cementitious Materials used also provide positive environmental impacts.
- Our Research utilization of lightweight aggregates and supplementary cementitious materials like slag and fly ash.

Objective

- To investigate the impact of different percentages of slag and fly ash on the compressive strength and carbon footprint of lightweight concrete.
- Highlighting the aim to minimize carbon emissions associated with concrete production while optimizing concrete strength

Significance of Lightweight Concrete

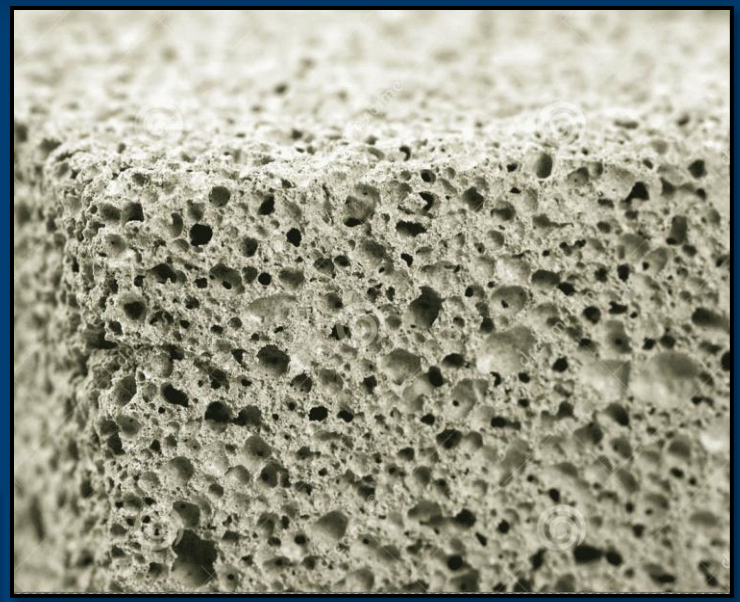
- Environmental Benefits

	NWC	LWC
Global Warming Potential (g CO_2)	71500	69000
Acidification Potential (g SO_2)	68800	66000
Eutrophication Potential (g PO_4)	77.5	74
Photochemical ozone creation potential (g C_2H_4)	25.3	23.5

- Economic Benefits
  - Cost per square foot of lightweight concrete is less than normal weight concrete
  - Reduce labor cost due to better workability

Significance of Lightweight Concrete Pt.2

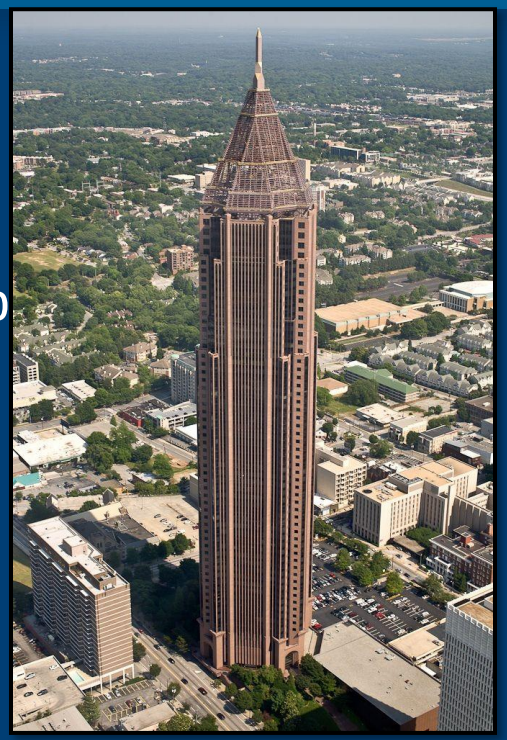
- Reduced Dead Load
  - Lower handling and transportation
  - Faster building rates
- Lightweight Aggregates
  - More Suitable for high seismic risk areas
- Improved Thermal Insulation
  - High Porous Aggregate



Structures Using Lightweight Concrete

- Bank of America Building Atlanta, Georgia
  - 55 Story High-Rise Building
  - Fire Rating Code was completed with thinner slab
  - 1 million dollars cheaper to build
  - Total Dead load was 13,000 LBS less

- 150 North Riverside Chicago, Illinois
  - 54 Story Skyscraper
  - 14,000 LBS of pumped LWC
  - “The pre-wetted lightweight aggregate concrete mix was very easy to work with;” Colin Chiluski, Prairie’s QC Technician



Bank of America Building

150 North Riverside

Role of Supplementary Cementitious Materials

- Slag
  - By-Product of Steel
  - Recycled material in concrete
  - Used as a cement replacement

- Fly Ash
  - Residue from combusting while pulverizing coal
  - Increased concrete durability and workability
  - Recycled material used as a cement replacement

Fly Ash

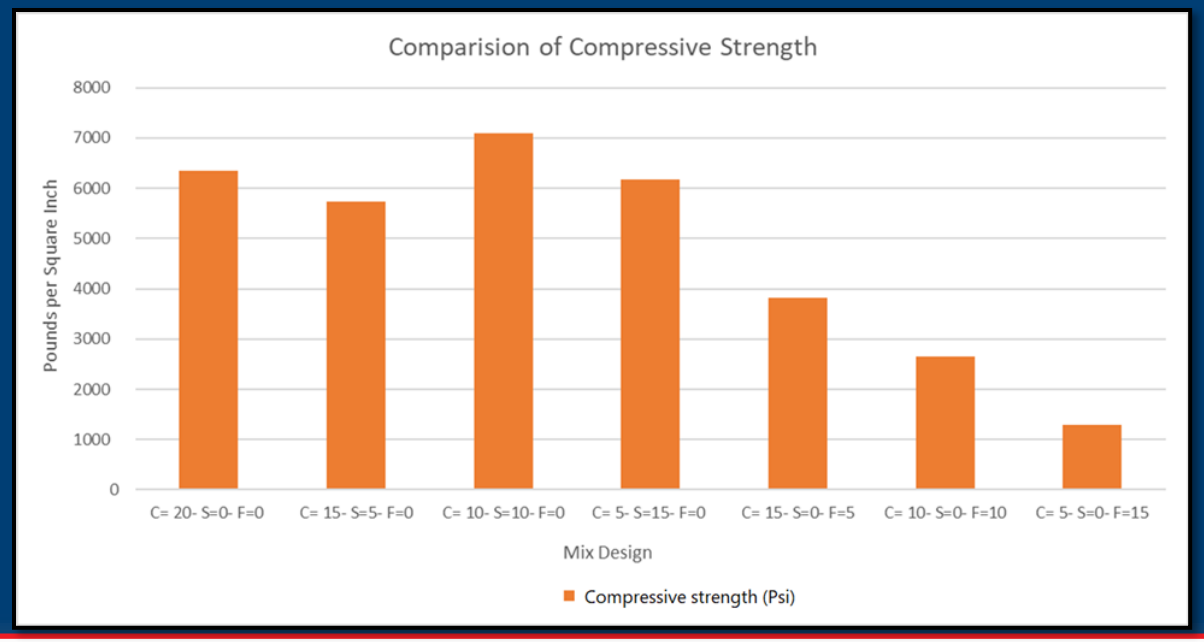
Slag

Research Methodology

- 7 Different Mix Designs
  - Mix 1 – C: 20%, F: 0%, S: 0%
  - Mix 2 – C: 15%, F: 0%, S: 5%
  - Mix 3 – C: 10%, F: 0%, S: 10%
  - Mix 4 – C: 5%, F: 0%, S: 15%
  - Mix 5 – C: 15%, F: 5%, S: 0%
  - Mix 6 – C: 10%, F: 10%, S: 0%
  - Mix 7 – C: 5%, F: 15%, S: 0%.
- All mixes contained
  - Silica Sand Fine Aggregate: 50%
  - Coarse Shale Aggregate: 21%
  - Water: 9%

Mix Design and Compressive Strength Results

- All 7 mixes were tested at 28 days
- The Results Yielded
- Average density: 130 lb/ft3
  - C: 10%, S: 10%, F:0% had the highest compressive strength



Conclusion

- Lightweight concrete is a innovation to the construction industry
- Maintaining concretes strength and durability
- Optimal Mix Design: Having an equal proportion of cement and slag (Mix 3) resulted in the highest compressive strength .
- Impact of Slag: Slag significantly enhanced compressive strength, indicating its effectiveness as a supplementary material.
- Environmental Benefits: Lightweight concrete and slag usage reduce carbon emissions, promoting sustainability in construction.
- Future Outlook: Continued research into mix optimization and alternative materials can further improve concrete performance and sustainability.

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