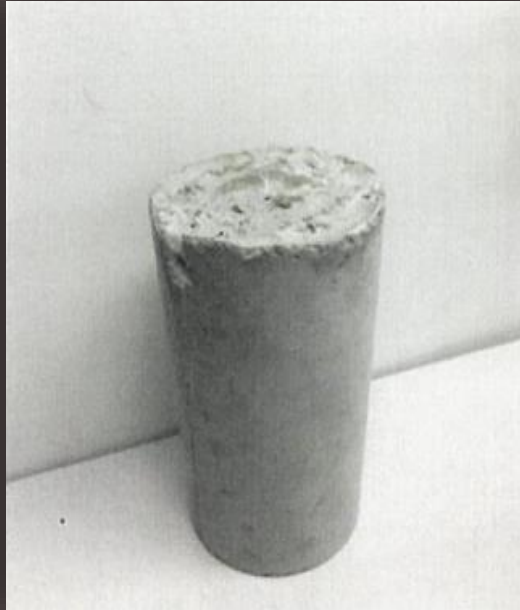


RECYCLED GLASS CONCRETE



Molten Sand Research Center

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Molten Sand Research Center

PROJECT BACKGROUND

■ Purpose of project

- To research concrete mix designs for pavement using recycled glass to achieve high strength concrete and to reduce alkali silica reaction (ASR)

■ Location

- Parking Lots and Sidewalks in Flagstaff

PROJECT BACKGROUND

■ Background Information

■ Previous Research

- Design formula
- Compressive load test results

Table 1: Glass to cement & sand ratio & Compressive Strength Results [1]

Mix Design	Experiment Detail	7Day Average (psi)	28 Days Average (psi)	Standard Deviation (28 Day)
1	Control (0% Glass)	6608	8557	503
2	10% Glass Powder	5865	8090	530
3	20% Glass Powder	5759	7458	1115
4	30% Glass Powder	5786	7772	603
5	10% Glass Coarse	5621	7401	239
6	20% Glass Coarse	5361	7215	166
7	30% Glass Coarse	5037	6552	256

STAKEHOLDERS

- **Client and Technical Advisor**
 - Dr. Chun-Hsing (Jun) Ho
- **Northern Arizona University (NAU)**
- **Engineering Community & Society**
- **Engineering Students**
- **People who will use parking lots and sidewalks**

TECHNICAL CONSIDERATIONS & CHALLENGES

- **Technical Considerations**
 - To find an appropriate range of cement/sand and recycled glass ratio
 - To reduce emission
 - Concrete mixing
 - Curing
 - Testing
 - Obtaining statistically significant data
- **Challenges:**
 - Obtaining the required materials
 - Time running tests

SCOPE OF SERVICES

- **Task 1.0 Research**
 - Task 1.1 Previous Projects
 - Task 1.2 Alkali Silica Reaction (ASR)
 - Task 1.3 Glass Size Properties
 - Task 1.4 Material Properties
- **Task 2.0 Developing Mix Formulae**
- **Task 3.0 Experimental Preparation**
 - Task 3.1 Material Acquisition
 - Task 3.2 Testing Equipment

SCOPE OF SERVICES CONT.

- **Task 4.0 Experimental Procedures**
 - Task 4.1 Mixing
 - Task 4.2 Curing
 - Task 4.3 Testing
- **Task 5.0 Data Analysis**
 - Task 5.1 Compressive Load
 - Task 5.2 Tension Splitting
 - Task 5.3 Temperature Cracking
 - Task 5.4 Statistical Analysis
 - Task 5.4.1 ANOVA
 - Task 5.4.2 T-test



Figure 1: Testing Equipment

SCOPE OF SERVICES CONT.

- **Task 6.0 Project Management**
 - Task 6.1 Team Management
 - Task 6.2 Client Management
 - Task 6.3 Deliverables
- **Exclusions**
 - Air void
 - Permeability test

PROJECT SCHEDULE



Figure 2: Project Gantt Chart

COST OF ENGINEERING SERVICES

Table 2: Staff Plan

Classifications	Code
Senior Engineer	SENG
Engineer	ENG
Lab Technician	LAB
Engineering Intern	INT
Administrative Assistant	AA

COST OF ENGINEERING SERVICES CONT.

Table 3: Total Hours for Staff

Staffing and Cost						
Major Task	Task	Hours				
		SENG	ENG	LAB	INT	AA
1.0 Literature Review	1.1 Previous Projects	4	10	0	12	0
	1.2 Alkali Silica Reaction (ASR)	4	20	0	8	0
	1.3 Glass Particle Size	3	15	0	6	0
	1.4 Material Properties	25	1	0	20	0
2.0 Developing Mix Formulae		3	40	0	22	0
3.0 Experimental Preparation	3.1 Material Acquisition	0	47	7	30	20
	3.2 Testing Equipment	0	3	15	0	0
4.0 Experimental Procedure & Data Analysis	4.1 Mixing	0	5	50	10	0
	4.2 Curing	0	0	1	0	0
	4.3 Testing	0	15	47	20	0
5.0 Project Management	5.1 Team Management	6	20	0	0	0
	5.2 Client Management	0	10	0	0	16
	5.3 50% Design Report	1	20	0	12	0
	5.4 Final Design Report	2	20	0	12	0
	5.5 Final Presentation	3	3	0	0	0
	5.6 Website	0	0	0	0	10
	Hours per worker	51	229	120	152	46
	Total Hours	598				

COST OF ENGINEERING SERVICES CONT.

Table 4: Total Cost Estimate

1.0 Personnel	Classification	Hours	Rate, \$/hr	Cost
	SENG	51	195	\$9,945
	ENG	229	67	\$15,350
	LAB	120	48	\$5,760
	INT	152	22	\$3,344
	AA	46	56	\$2,576
	Total personnel			\$36,975
2.0 Travel	2 Trips*7.4miles/ Trip	\$0.40/mi		\$12
3.0 Lab Rental		120	30	\$3,600
4.0 TOTAL				\$40,437

REFERENCES

[1] Brumit, T, W, Ibrahim, A. and Wang, Crushed Glass as a Sustainable Alternative Aggregate For Concrete. Rep. Vol. Phase one. Flagstaff: Northern Arizona U, 2015.

Questions?