GLASS MOUNTAIN
LIGHTWEIGHT AGGREGATE

A true 110 pound per cubic foot natural lightweight concrete is now available to the construction industry, through Glass Mountain.

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Lite-Rock™

Glass Mountain Lightweight Aggregate is currently supplying Lite-Rock™ lightweight concrete aggregate to the western United States from our mine and processing plant in Tulelake, California, approximately 60 miles southeast of Klamath Falls, Oregon, and from our Power Inn rail unloading center on the south side of Sacramento, California.

This successful use of Glass Mountain Lite-Rock™ in structural lightweight concrete has been repeatedly substantiated by engineering tests and satisfactory placements. Lite-Rock™ aggregate surpasses the conditions of acceptance for ASTM C-330 "Lightweight aggregates for Structural Concrete" as tested by Kleinfelder, Inc. and ASTM E-119 "Fire Tests of Building Construction and Materials" as tested by Omega Point Laboratories. This natural material provides a true 110 pcf lightweight structural concrete for the construction industry.

Glass Mountain Lite-Rock™ has been approved for use by many government agencies, including the California State Fire Marshal, the City of Los Angeles Dept. of Building and Safety, and Cal Trans of California. Many public projects, including schools, hospitals, and prisons have utilized Lite-Rock™ in fire-rated structural roof and floor assemblies and in lightweight tilt-up panel construction. This material has also been used by Cal Trans and other customers for lightweight fill material for several projects throughout Oakland and the San Francisco Bay Area.

LIGHTWEIGHT CONCRETE SPECIFICATION

ASTM C-330 ("Specification for Lightweight Aggregates for Structural Concrete") or the equivalent UBC 26-3 is considered to be the standard specification for the course aggregate in structural lightweight concrete. Supporting information can be found in ACI 213R ("Guide for Structural Lightweight Aggregate Concrete"). Both of these publications indicate there are a number of sources of natural lightweight aggregates such as pumice, scoria, and cinders capable of meeting the specifications for structural lightweight concrete. Glass Mountain aggregates have proven time and time again to be superior to other natural lightweight aggregates.

GLASS MOUNTAIN LITE-ROCK™
IN STRUCTURAL LIGHTWEIGHT CONCRETE

Glass Mountain Lite-Rock™ is a superior quality natural lightweight aggregate, which surpasses all of the general specification requirements for structural lightweight Concrete as defined by ASTM C-330 (UBC 26-3) “Lightweight Aggregates for Structural Concrete.”

- **Lightweight and High Strength:** Capable of producing concrete utilizing standard mix designs with 28 day Compressive Strengths in the range of 3,000 to 5,000 psi at Air Dry Unit Weights of 110 to 112 pcf.

- **Fire-Rating Certification:** Successfully meets the conditions of acceptance outlined in ASTM E119 for a Fire Endurance Rating of two to four hours in structural floor and roof assemblies depending on thickness. Tests indicate concrete made with Lite-Rock™ transmits less than half as much heat as normal weight concrete of similar thickness.

- **Recognized Quality:** Approved for use in structural lightweight concrete by many government agencies, including the City of Los Angeles. Cal Trans has approved this material for both lightweight concrete and fill material.

- **Quality Control:** Consistent Unit Weights, Gradation, Specific Gravity, and Saturation ensure proper mix proportioning, pumpability, and workability.

- **Proven Performance Through Testing:** Repeated testing by nationally recognized laboratories has proven Glass Mountain Lite-Rock™ meets ASTM specifications for Gradation, Drying Shrinkage, Splitting Tensile Strength, Organic Impurities, Staining, Loss on Ignition, Clay Lumps, Popouts, and Durability.

- **High Silica Content:** Chemical analyses indicate a silica value greater than nearly all other pumices on a worldwide basis. This high silica content imparts exceptional hardness resulting in cubical aggregate particles, which offer excellent bonding to the matrix.

- **Unique Cellular Nature:** Abundant Microscopic spaces lead to a slow release of moisture with time, thereby extending the chemical reactions which yield stronger concrete. Additionally, this physical property results in an exceptional thermal insulation factor. This cellular nature has also proven to provide enhanced air entrainment properties providing a higher level of natural entrapped air. This can eliminate the need for air-entrained admixtures.

- **Color Neutral:** Uniformly off-white in color but is receptive to colorant.

SPECIFY GLASS MOUNTAIN LITE-ROCK™ IN YOUR MIX DESIGN

Mix Design Proportions
As reported by Kleinfelder, Inc., on November 20, 2002, Job# 13624.01
4875 Longley Lane, Suite 100, Reno, Nevada 89502
Phone: (775) 689-7800

	5.0 Sack – One cubic yard	
	Weight	Volume, CF
Concrete (lbs)	467	2.38
Water (lbs)	263	4.21
½" x #4 Pumice (lbs)	815*	9.32
Sand – Teichert (lbs)	1,666**	10.1
Polyheed 997 (ozs)	47	0.05
Air Content Percentage (entrapped)	--	0.95
Total	**3,214**	**27.01**

	Compressive Strength, psi.
Average 3 day	2080
Average 7 day	2650
Average 14 day	3110
Average 28 day	3340

	6.5 Sack – One cubic yard	
	Weight	Volume, CF
Concrete (lbs)	611	3.11
Water (lbs)	265	4.25
½" x #4 Pumice (lbs)	815*	9.32
Sand – Teichert (lbs)	1,544**	9.37
Polyheed 997 (ozs)	61	0.06
Air Content Percentage (entrapped)	--	.87
Total	**3,239**	**26.98**

	Compressive Strength, psi.
Average 3 day	3190
Average 7 day	3840
Average 14 day	4020
Average 28 day	4300

	8.0 Sack – One cubic yard	
	Weight	Volume, CF
Concrete (lbs)	752	3.83
Water (lbs)	270	4.33
½" x #4 Pumice (lbs)	815*	9.32
Sand – Teichert (lbs)	1,380**	8.38
Polyheed 997 (ozs)	75	0.08
Air Content Percentage (entrapped)	--	0.68
Total	**3,222**	**26.62**

	Compressive Strength, psi.
Average 3 day	3900
Average 7 day	4330
Average 14 day	4510
Average 28 day	4770

The mix proportions presented are for guidance and estimating purposes only and are not a guarantee of performance by Glass Mountain Pumice, Inc. We would advise our clients that due to the variance in performance of local materials, testing should be done to ensure conformance with specifications, and that mix proportions should be evaluated for conformance to project specifications by a certified, approved testing laboratory.

Substantial Improvements in the performance of Lightweight Structural Concrete Using Pumice as the Lightweight Aggregate

Dr. David E. Lock, Technical Services

During May 2002, Glass Mountain ran a series of mix design trials to increase the compressive strength of concrete mixes made with pumice aggregates. These trials mark the beginning of a development campaign by Glass Mountain to improve the performance of structural lightweight concretes made with pumice aggregates. The company wants to enhance the performance credibility of pumiceous concretes in general, passing on economic and performance advantages to the construction industry.

The study was designed as a guide for new mix designs which can now compete with the strength of concretes produced with expanded shale and some medium-weight aggregates. The mixes are based on a new concrete aggregate product specifically designed for the purpose. Mixes can now be available with consistent 28-day strengths of near 5000 psi, and 7-day strengths exceeding 3000 psi with just 5½-sacks of cement per cu yd of concrete.

The Proportioning Trial was based on the method ACI 211.2-98 'Standard Practice for Selecting Proportions for Structural Lightweight Concrete' and was carried out on three different mixes spanning likely mix design criteria. This has enabled the selection of best proportions of aggregate and cement content for future mix designs. A new grading for our pumice lightweight aggregate was adopted for the mixes, with a reduced -200 mesh component.

Introduction

Historically, our pumice aggregate has been used by the concrete industry in 'premium' mixes for lightweight structural concrete applications, but strength development has been slow in the early-set period, with 28-day strengths relatively low, compared to medium weight concretes. Depending on the mix design used by batch plants, 28-day breaks often ranged between 3200-4000 psi for a 6½-sack mix, with 5-6% air. The minimum specified 28-day break was often 3000 psi for these applications.

The new studies were aimed at increasing early-strengths, and increasing overall compressive strengths of pumice-based concretes.

The trial was run after petrographic examination of these concretes by Dr. David Lock. It suggested that the -200 Mesh contents of the course aggregate lead to considerable volumes of fine-aggregate paste development in the mix. Late water release from the more porous coarse aggregate slowed the development of final strengths in the paste, which often came with paste shrinkage. The trial has demonstrated that reducing -200 Mesh fines in our new Conrock has provided new concrete mixes which show up to 45% improvement in 28-day compressive strengths over current mixes for the same cement contents, and substantially improved early compressive strength development.

Mix Proportioning

Mix proportioning was calculated on the basis of 5, 6½, and 8 sacks per yard cement contents, for a coarse lightweight aggregate of ½" maximum nominal size (ASTM C330 ½" - #4 Mesh). In these trials, our concrete aggregate contained -200 Mesh contents of only 2.8% compared with previous levels of 15-20%. The coarse aggregate was matched with medium-weight impervious sand from the Teichert-Perkins operation near Sacramento. Nevada Cement powder of Type II (low-alkali) was used, along with 10 oz per cwt cement of Masterbuilders Polyheed 997 as a mid-range water-reducer. In current mixes, Polyheed 997 is often used to extend the slump on batch mixes to 6-8" without the need for additional water. This allows workability at slumps of 4-5" after emplacement by pumping. To enhance compressive strengths, no air was added to the trial mixes, as it is anticipated that such mixes will be used in the Bay and Sacramento areas where freeze-thaw conditions are not critical.

Factors Used in the Mix Proportioning Trial

For satisfactory workability associated with pumping, a slump of 4-5" was chosen as a target for proportioning the mix. When combined with the addition of Polyheed 997 a pre-pumping slump of 6-8" would be a reasonable outcome without further water addition to the batched mix.

The nominal maximum size of the Glass Mountain lightweight coarse aggregate for the mix was ½", pertaining to the ASTM C330 spec for ½"- #4 Mesh grading. The -200 Mesh component of its grading was 2.8%. Its as-received moisture content was 38%, with a typical Water Absorption of 22%, indicating some 16% free water content. Dry loose unit wt was 34.9 pcf. This was combined with an impervious Consand from the Teichert-Perkins operation in Sacramento, which had an FM of 2.79, a -200 Mesh content of 2.9%. As-received Water Content was 4.3% with a Water Absorption of 2.5%, providing 1.8% Free Water available to the mix.

In the estimation of Mixing Water and Air Content, no entrained air was added, in order to maximize compressive strength development. It was envisioned that these mixes would be used in the Bay and Sacramento areas, where severe freeze-thaw protection would not be an issue. Nevertheless, it was estimated that up to 4% of entrapped air inside the porous pumice would have to be accommodated in the mix proportioning. Mixing Water Content was then calculated for an air-entrained concrete with up to 4% air, with mild freeze-thaw exposure. In the selection of an approximate water-cement ratio, a 28-day target of 3000 psi compressive strength was chosen. On this basis, cement contents were then calculated. In the estimation of the content of fine aggregate, a Specific Gravity Factor for the concrete mix was measured at 1.40. The proportion of fine aggregate influences Concrete Unit Wt (Air Dry). Slumps were measured on all three mixes during the trial.

Once proportions were calculated, they were adjusted to cement contents of 5, 6½, and 8 sacks per concrete yard to provide a range over which engineers could estimate both final strengths and strength development, correlated with cement contents and w/c ratios. Results are presented in the attached plot.

The trial mixes gave lower than expected slumps of 2-2½", and this is likely due to difficulties in estimating free-water available to the mix from the coarse aggregate (saturating the stone). This difficulty can be overcome at batch plants once experience is gained in relating as-received moisture content and free water availability from the saturated coarse aggregate. In addition, the proportional content of fine aggregate (Consand) could only be estimated on the basis of a measurement of the Specific Gravity Factor for coarse aggregate, which will affect slump. Air contents will also have an effect on slump.

Conclusion

On the whole, by producing a ½" Lightweight Conrock Aggregate with a substantially reduced -200 Mesh component, Glass Mountain Lightweight Aggregate has now opened up the opportunity for 28-day compressive strengths of the order 5000 psi, and 7-day compressive strengths in excess of a minimum specified requirement of 3000 psi.

This is a substantial improvement in the strength performance of Lightweight Structural Concretes based on our pumice aggregate, which we hope will be of greater value to batch plants and the construction engineering community.