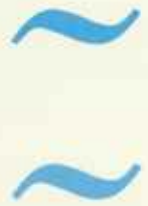




~ **Go With The Flow** ~

Pumping Structural  
Lightweight Concrete





**N**ew pumping technologies and a better understanding of the properties of lightweight aggregate have given rise to easier and more efficient operations for pumping structural lightweight concrete.

~ Using this information, lightweight aggregate manufacturers, ready-mix producers, building and pumping contractors are working in concert with architects and engineers in a true "team approach" toward efficient use of lightweight concrete in today's structures.

With this team approach, ready-to-pump lightweight structural concrete can be produced, delivered, and placed without complication.

~ The following guidelines are intended to contribute to the success of your pumping operation.



**First Interstate World Trade Center:**  
Los Angeles, California (75 Stories)  
Architect: I.M. Pei & Partners  
Structural Engineer: CBM Engineers, Inc.  
General Contractor: Turner Construction Company

### **Aggregate Saturation**

~ The porous nature of lightweight aggregate may cause the material to absorb water when subjected to pumping pressures. Therefore, to achieve maximum pumpability for lightweight concrete, prewetting the lightweight aggregate is required. The prewetting process aids in preventing the aggregate from absorbing water during the pumping process and allows the concrete to be delivered in a ready-to-pump condition. This minimizes slump loss, increases pumpability, and maintains consistency.

### **Fresh & Cured Concrete Density**

~ Prewetting the lightweight aggregate makes it more dense and the fresh unit weight of the concrete increases proportionately. The water absorbed into the aggregate helps promote beneficial internal curing of the lightweight concrete. This water is ultimately lost in the natural drying process which takes about 90 days for the concrete to approach density equilibrium. More economical mixes may be used if design conditions for strength and/or unit weight can be extended to 56 or 90 days. The lightweight aggregate manufacturer should be consulted for specific concrete properties and mix design recommendations.

### **Mix Design Considerations**

~ Some lightweight concrete may lose slump and/or air content during pumping. This should be anticipated when preparing the mix.

~ The total water content of the pumpable lightweight concrete mix is composed of two parts: water absorbed inside the lightweight aggregate, and free water. The absorbed water does not affect the cement paste; therefore, as noted in ASTM C 125 (Concrete and Concrete Aggregates), absorbed water is not used when calculating the water-cement ratio.

### **Trial Pump**

~ A pre-job field trial is recommended. The actual job site pumping equipment and mix design should be used. The participants should include the contractor, architect, structural engineer, ready-mix supplier, pumper, testing laboratory, and the lightweight aggregate supplier. For the trial, simulate as closely as possible the distance and height that the lightweight concrete is to be pumped at the actual construction site.

### **The Pumping System**

~ Avoid rapid reduction in line size from the pump to the lines. Use the largest size line available. Operating pressure inside the line should be as low as functionally possible; this may be accomplished by maximizing the amount of steel line and minimizing the number of elbows, reducers, and rubber hose in the system.

### **Field Adjustments**

~ The architect, engineer, contractor, and pumper must be aware as the job progresses that certain adjustments of the mix design (slump, air, aggregate proportions, cement, etc.) may be necessary. An economical mix design with adequate pumpability for a low-rise building may not be suitable for a high-rise building.

### **Testing**

~ Sample the concrete at the point of discharge from the pump. Allow higher slump and air content for concrete going into the pump to compensate for possible loss during pumping and to achieve the desired in-place result.

**One Utah Center, Salt Lake City, Utah (24 Stories)**  
Architect: Valentiner Associates  
Structural Engineer: Reaveley Engineers & Associates  
General Contractor: Jacobsen Construction



## "THE TEAM APPROACH"

### Design Engineer

1. Mixes that are regularly used in a market area will be the most economical. Consult the lightweight aggregate suppliers for detailed mix design information and material capabilities (i.e. unit weight, strength, etc.).

2. Specify 4 to 7 percent air entrainment for pumpability, workability, finishability, and durability.

3. Specify the maximum size aggregate rather than specifying individual sizes.

4. Allow higher slump into the pump to accommodate possible slump loss.

5. Have the testing lab run design curves based on the maximum specified slump and air per ACI 301.

6. Specify a pre-pump meeting with the following present: engineer, architect, contractor, ready-mix supplier, lightweight aggregate supplier, testing agency, admixture supplier, and pumping contractor.

7. On large jobs, these same people should be present at the first concrete pump placement.

8. Specify exactly where concrete should be tested, preferably at the end of the discharge line as per ACI 304.2R.

9. Realize that absorbed water does not affect water/cement ratio, as defined in ASTM C 125.

### General Contractor

1. Keep everyone communicating; this is a team effort!

2. Use an experienced pumping contractor.

3. Make arrangements for two ready-mix trucks to unload simultaneously.

4. Designate a laborer to help the testing lab inspector.

5. Provide a washout area for ready-mix trucks.

6. Make use of the ready-mix truck radio when placement delays occur.

7. Specify to the ready-mix supplier the number of yards needed per hour, not how many truckloads.

8. Make an agreement with the ready-mix supplier as to how the quantity of concrete delivered will be determined.

9. It is necessary to properly lubricate the pump line before placing concrete.

### Pumping Contractor

1. Know the concrete unit weight being pumped.

2. Order concrete to coincide with actual pumping time, not when the pump arrives at the job site.

3. Maintain continuous placement.

4. Operator should know the maximum slump allowed.

5. Use 5" minimum clean steel lines; minimize rubber at end of line; avoid reducers if possible.

6. Keep the same pump and operator throughout the duration of the job.

7. Use a pump whose piston size is as close as possible to the line size to maintain the best performance and least slump loss.

### Ready-Mix Producers

1. The lightweight aggregate must be pre-wetted prior to batching using procedures recommended by the lightweight aggregate supplier.

2. Check with the lightweight aggregate supplier for recommended pump mix design and field correction procedures.

3. The aggregate moisture content or unit weight should be checked every time bins are filled. This is necessary for concrete yield control.

4. Make drivers aware of what admixtures are being used for slump control.



5. Maintain a minimum 3" slump before the addition of "super-plasticizer."

### Testing Labs

1. The field inspector shall be ACI Field Technician Grade 1 (or equivalent), per ASTM C 94.

2. Make sure the inspector has the proper tools including a roll-a-meter for volumetric air tests and a proper strike-off plate for unit weight determination.

3. On large jobs use the same inspector for all concrete placements.

4. The inspector should know fresh unit weight limitations (min & max).

5. Place test cylinders immediately upon casting in a curing box protected from vibration per ASTM C 31.

~ For more information about pumping structural lightweight concrete, contact the producer of Rotary Kiln Expanded Shale, Clay, or Slate Lightweight Aggregate.





## Wherever you live, work or play, ESCS improves your world!

For nearly one hundred years ESCS (Expanded Shale, Clay and Slate) has been used successfully around the world in more than 50 different types of applications. The most notable among these are concrete masonry, high-rise buildings, concrete bridge decks, precast and prestressed concrete elements, asphalt road surfaces, soil conditioner and geotechnical fills.

What is ESCS? It is a unique, ceramic lightweight aggregate prepared by expanding select minerals in a rotary kiln at temperatures over 1000°C. The production and the raw materials selection processes are strictly controlled to insure a uniform, high quality product that is structurally strong, stable, durable and inert, yet also lightweight and insulative. ESCS gives designers greater flexibility in creating solutions to meet the challenges of dead load, terrain, seismic conditions, construction schedules and budgets in today's marketplace.

Expanded shale, clay and slate aggregate, as manufactured by the rotary kiln process (originally developed in 1908 and patented in 1918 as *Haydite*), is available throughout the world.



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