Technical Bulletin

11 Fly Ash for Pumped Concrete

MIX HOMOGENEITY. The designer must be aware of the need to improve gradation and maintain uniformity of the various materials used in the pumped mix in order to achieve greater homogeneity of the total mix.[1] Three mix proportioning methods frequently used to produce pumpable concrete are:

- Maximum Density of Combined Materials
- Maximum Density – Least Voids
- Minimum Voids – Minimum Area

Mixes must be designed with several factors in mind:

1. Pumped concrete must be more fluid, with enough fine material and water to fill internal voids.
2. Since the surface area and void content of fine material below 300 microns control the liquid under pressure, there must be more of these sizes than in a normal mix. Generally speaking, the finer the material, the greater the control.
3. The coarse aggregate grading should be continuous and often the sand content must be increased by up to five percent at the expense of the coarser aggregate so as to balance the 500 micron - 5mm fraction against the finer solids.

Pumped concrete must be designed so that it can be easily conveyed by pressure through a rigid pipe or flexible hose for discharge directly into the desired area. Fly ash use can greatly improve pumpability while enhancing the quality of the concrete and controlling costs.

FLY ASH IS AN EFFECTIVE REMEDY. Unfortunately, adding extra water and fine aggregate leads to a weaker concrete. The usual remedies for this are either to increase the cement content, which is costly, or to use chemical admixtures, which also can be costly and may lead to segregation in marginal mixes. There is another and far more effective alternative: fly ash.

There are many advantages to including fly ash in concrete mixes to be pumped. Among them are:

1. **Particle Size.** Fly ash meeting ASTM Specification 618 must have 66% passing the 325 (45-micron) sieve, and these fine particles are ideal for void filling. Just a small deficiency in the mix fines can often prevent successful pumping.
2. **Particle Shape.** Microscopic examination shows most fly ash particles are spherical and act like miniature ball bearings, aiding the movement of the concrete by reducing frictional losses in the pump and piping. Studies have shown that fly ash can be twice as effective as cement in improving workability and, therefore, pumpability.[2]
3. **Pozzolanic Activity.** This chemical reaction combines the fly ash particles with the calcium hydroxide liberated through the hydration of cement to form additional cementitious compounds, which increase concrete strength.
4. **Water Requirement.** Excess water in pumped mixes resulting in over six inch slumps will often cause material segregation and result in line blockage. As in conventionally placed mixes, pumped concrete mixes with excessive water also contribute to lower strength, increased bleeding and shrinkage. The use of fly ash in pumped or conventionally placed mixes can reduce the water requirement by 2% to 10% for any given slump.[3]
5. **Sand/Coarse Aggregate Ratio.** In pumped mixes, the inclusion of liberal quantities of coarse aggregate can be very beneficial because it reduces the total aggregate surface area, thereby increasing the effectiveness of the available cementitious paste. This approach is in keeping with the "minimum voids, minimum area" proportioning method. As aggregate size increases, so does the optimum quantity of coarse aggregate. Unfortunately, this process frequently is reversed in pump mixes, and sand will be substituted for coarse aggregate to make pumping easier. When that happens, there is a need to increase costly cementitious material to compensate for strength loss. However, if fly ash is utilized, its unique workability and pumpability properties permit a better balance of sand to coarse aggregate, resulting in a more economical, pumpable concrete.

[1] "Proportioning Concrete Mixes" - ACI Publications SP-46, p. 27.
[2] Missner, H.S., "Effect of Inert Mineral Additives on Workability", Significance of Tests and Properties of Concrete and
[3] "Concrete Making Materials", STP 169-A American Society for Testing and Materials, Philadelphia, 1966, pp. 404-414.

For more information or answers to questions about the use of fly ash in specific applications, contact your nearest Headwaters Resources Technical Sales Representative or call 1-888-236-6236.

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