HAHN READY MIX

Pumping Concrete

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Why Pump Concrete?

The ability to pump concrete is an important tool for concrete contractors. Pumping allows concrete to reach elevated areas, hard to reach spaces, or places that cannot support the weight of a mixer truck. In many cases, pouring with a pump significantly increases the speed of placement, reducing labor costs. Depending on pour complexity, mix design, and delivery, pumps can often move up to ~150 cubic yards per hour.

Types of Pumps

There are two main types of pumps, boom pumps, and line pumps.

Boom pumps are truck-mounted pumps, with a remote-controlled boom arm carrying a steel pump line. A rubber hose is typically attached to the end of the line. Hydraulic pistons drive the concrete through the pump line and out the other end.

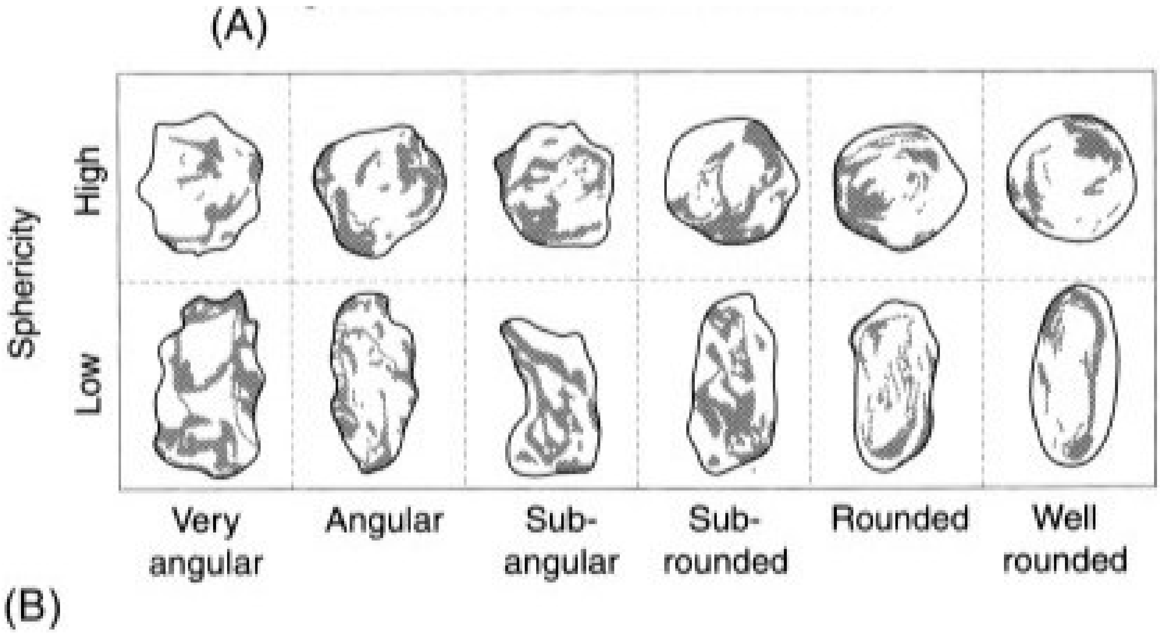
Line pumps are often trailered pumps that have some combination of rubber and steel lines attached. These systems are typically cheaper to rent or purchase but are much less mobile during a pour.

Can any kind of concrete be pumped?

The short answer is no. Pumpability of concrete mixes comes down to aggregate size, gradation, particle shape and absorption, cementitious quantity and products, water contents, and admixtures.

Aggregates

Coarse aggregates in a concrete mix should be no larger than 1/3 the diameter of the narrowest section of pipe or hose. Any larger aggregate could get caught in any line bends and plug the pump line.



Aggregates, particularly fine aggregates, that are angular or elongated are very difficult to pump. Rounded fine aggregates like natural river sands are a huge advantage in creating a pumpable concrete mix.

Aggregates with high absorption potential, such as lightweight aggregates, need to be fully saturated with water prior to concrete production. If not fully saturated, the pressure form the pump will force moisture from the concrete mix into the pores of the aggregate, resulting in a significant loss of slump and likely plugging the pump.

Individual and combined aggregate gradations also play an important role. A mix that has too much coarse aggregate in proportion to fine aggregate will struggle to pump. Mixes in our area are generally pumpable with 55% or less coarse aggregate. In Muscatine, for example, our normal state-approved sand is a little shy on fine material to consistently pump. For this reason, we ask while taking orders if the concrete is to be pumped, so we can use a sand with a slightly different gradation that is more pump-friendly.

Paste

The most important factor for pumpability in regards to cementitious materials is that it is necessary for there to be enough paste in the mix to coat all the aggregates. Paste is made up of the cementitious materials, water, and entrained air. If the volume of these materials is greater than 27-28% of the total volume of the mix design, it should be sufficient to pump.

In addition, different cementitious materials have differing pumpability. Cement is decently pumpable, but replacing some cement with fly ash will certainly improve pumpability due to fly ash's spherical particle shape. Slag on the other hand, may slightly decrease pumpability when replacing cement, especially at high replacement levels.

Admixtures

Certain admixtures can greatly aid in the pumpability of concrete, depending on how they are used. If you recall Tech Bulletin #10, water reducers can be used to decrease the water at a given slump, or increase the slump at a given w/cm ratio. The former will actually compromise pumpability because the paste volume is lessened. The latter will increase pumpability to a certain point as the mix is more fluid. Too much water reducer, or too much water, will eventually make the mix prone to segregation, after which it will be extremely difficult to pump. A 6-7" slump seems to be the optimal pumping slump.

Air entrainment generally helps pumpability, but the real game changer in the admixture pumpability world is a viscosity modifying admixture. A VMA can mitigate issues with low paste volume, angular aggregates, or segregation.

How does a pump affect the properties of concrete?

The act of putting concrete under pressure through a pump has intrinsic effects on the concrete mix. First, a reduction in air content is generally to be expected. Do the air bubbles pop under pressure, or perhaps just temporarily constrict? A hot debate in the industry, currently. Either way, an air test after a pump will typically be 1-2% lower than the test before a pump. The amount of air loss is highly dependent on the pump pressure and the angle of the boom. A high arc with a large amount of fall will also cause larger air losses. It is not unheard of to have air gain through a pump as well, although this is much more rare. Testing the air content of concrete after a pump is critical for understanding in-place air content, and retests should be down after a significant change in the boom angle, or change in the pump machine. A significant point of contention in the concrete industry is answering the question "who is responsible for air contents after a pump?", as a ready mix supplier, we staunchly take the position that the producer should be held responsible for the air content at point of discharge from the mixer, as there is no way for us to control or influence the air loss through a pump.

There is also some loss of slump seen typically through pumping. This effect is most obviously seen on the first load that goes through an unprimed system, but some moisture is likely being forced into the aggregates even with moderately absorptive material. Slump losses are not normally more than 1" unless you are dealing with a highly absorptive aggregate. Slump loss is exacerbated by long systems and especially rubber line.

Common Pumping Problems

As mentioned above, slump loss and plugging on the first load of concrete is often a problem. Properly priming longer systems or when using difficult to pump mixes is critical. A priming aid such as a slick-pak is common, and the best method for priming is using a yard of a rich grout mix to coat the system.

One of the most common issues with pumping is a plug at a reducer section when the line diameter decreases. The pressures are higher at this point and can cause segregation and rock jams in this area easily. Minimizing the amount of reducers and using longer reducer sections are good strategies for mitigating the chances of a blockage in the pump line.

Conclusion

A concrete pump is an important and versatile tool for use in modern construction. If utilized properly, a pump can save time, effort, and expense. Knowing what mix designs can be pumped and what tools exist to address pumpability issues are key for a successful pumping experience.

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