

What is Time of Set?

Time of set is defined as the point in time at which penetration resistance reaches specified values. ASTM C403 identifies initial and final time of set as:

Penetration Resistance	
Initial Time of Set:	500 psi
Final Time of Set:	4000 psi

Typically to a concrete contractor, initial time of set refers to the time at which a concrete surface can bear the weight of an individual with minimal indentation.

When water comes into contact with hydraulic cement, a chemical reaction called hydration occurs. This reaction combines water with cement forming chemical compounds, increasing the strength of the material and changing it from a plastic, moldable material to a solid capable of withstanding substantial loads.



Why is Time of Set Significant?

Initial and final set times are important because they give an indication of when the concrete can be properly placed, consolidated, and finished.

What Influences Time of Set?

Among other things, the initial and final time of set are influenced by:

- Cementitious material chemistry
- Cementitious material fineness
- Cementitious material content
- Water to cementitious materials ratio
- Concrete and ambient temperatures
- Admixture types
- Fly ash and pozzolan properties



How Does Slag Cement Affect Time of Set?

At temperatures less than 85 degrees Fahrenheit, concrete containing slag cement can have longer times of set, when compared with 100 percent portland cement concrete. The lower the ambient and/or concrete temperatures, the slower the set times will be (Figure 1). The percentage of slag cement used can also affect times of set. However, replacement rates of less than 30 percent

generally will not affect times of set significantly. Slower times of set are beneficial in hot weather because the contractor has a longer time to deliver, place, and finish the concrete. If times of set need to be reduced, accelerators, heated materials or reduced slag cement content may be used (Figure 2)

Set time may influence factors such as timing of saw cuts, removal of forms, and loading. Refer to ACI 318: Building Code Requirements for Structural Concrete and ACI 347: Guide to Formwork for Concrete that have recommended various minimum time periods for form removal, saw cutting, and loading of placed concrete.

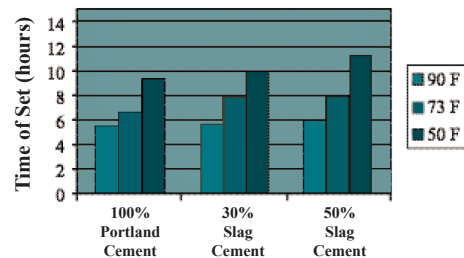


Figure 1: Effect of Temperature on Initial Time of Set

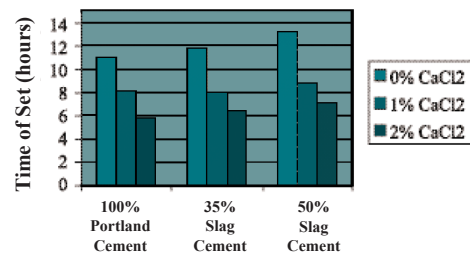


Figure 2: Effect of Accelerators on Initial Time of Set

References

1. ACI 318-19, "Building Code Requirements for Structural Concrete and Commentary," American Concrete Institute, Farmington Hills, MI, 2019.
2. ACI 347-14, "Guide to Formwork for Concrete." American Concrete Institute, Farmington Hills, MI, 2014.
3. C403/C403M-99, "Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance." American Society for Testing and Materials, West Conshohocken, PA, 2001.

As with all concrete mixtures, trial batches should be performed to verify concrete properties. Results may vary due to a variety of circumstances, including temperature and mixture components, among other things. You should consult your slag cement professional for assistance. Nothing contained herein shall be considered or construed as a warranty or guarantee, either expressed or implied, including any warranty of fitness for a particular purpose.