

Free Fall of Concrete

Concrete placing operations are often planned to allow for the free fall of concrete. This planning must also consider any segregation that might occur when the concrete free falls into place. Techniques such as placing concrete with drop chutes or through windows in wall forms can minimize the effects of concrete free fall. Using these measures unnecessarily, however, can increase concreting costs without improving the in-place quality of the concrete.

Sometimes specifiers and inspectors dictate the maximum free-fall distance of concrete because they believe limiting free fall is necessary to minimize concrete segregation. Usually they limit the free-fall distance to 3 to 5 ft (0.9 to 1.5 m), but occasionally the limit is as little as 2 ft (0.6 m). Neither ACI 301-99, "Specifications for Structural Concrete," nor ACI 318-02, "Building Code Requirements for Structural Concrete," limit the maximum distance concrete can free fall. ACI 304R-00, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," states that "if forms are sufficiently open and clear so that the concrete is not disturbed in a vertical fall into place, direct discharge without the use of hoppers, trunks, or chutes is favorable." ACI 301, 304, and 318, however, all require placing the concrete at or near its final position to avoid segregation due to flowing.

At least four field studies have shown that free fall from great distances doesn't reduce concrete quality:

- "Investigation of the Free-Fall Method of Placing High-Strength Concrete in Deep Caisson Foundations," C. N. Baker, Jr., and J. P. Gnaedinger, 1960 report;
- "Unconfined Free-Fall of Concrete," C. D. Turner, ACI JOURNAL, Dec. 1970, pp. 975-976;

- "Concrete Free Fall Tested in Alabama Highway Department Project," S. Litke, Foundation Drilling, June-July 1992, pp. 14-16; and
- The Effects of Free Fall on Concrete in Drilled Shafts, STS Consultants Ltd., report to the Federal Highway Administration, 1994.

Although all the field studies have been for caissons, the results should also apply to other structural elements such as walls, columns, and mat foundations. In the Chicago, IL, area, contractors routinely construct concrete caissons by allowing the concrete to free fall to depths of up to 150 ft (46 m). Full-length cores taken from more than 100 of these caissons over a 30-year period have shown no evidence of segregation or weakened concrete. The 1994 FHWA study provided test data leading the investigators to conclude that "the general expectation that (concrete) striking of the rebar cage will cause segregation or weakened concrete is invalid" and they found "no segregation or strength differences between low- and high-slump concrete mixtures."

In 1999, the Federal Highway Administration eliminated its 25 ft (8 m) free-fall limitation and now allows unlimited free fall of concrete. Free fall of concrete from heights of up to 150 ft (46 m), directly over reinforcement or at high slumps, does not cause segregation or reduce compressive strength. Restricting free-fall heights does decrease concrete production rates, which increases owners' costs without increasing concrete quality.

ASCC concrete contractors will work with specifiers in developing specifications that address these issues. If you have any questions, contact your ASCC concrete contractor or the ASCC Technical Hotline at (800) 331-0668.