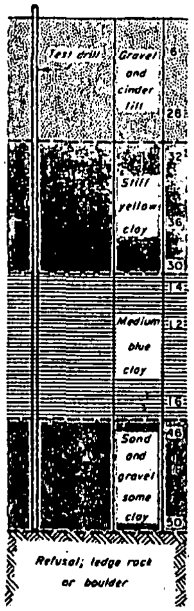
# Soil's Load-Bearing Ability Is Checked Prior to Driving Piles for Turbine And Building Supports




TEST BORING before pile driving. Figures to right show blows needed to drive 1 ft

PIPE PILE being driven as part of the foundation for a 50,000-kw extension

AFTER DRIVING pipe shell to full depth compressed air handles final cleanout

STEEL CORE is then lowered into shell for transmitting load to the rock bed

# Structural Support for Plant Loads

**• Briefing on fundamentals of concreting, equipment foundations, plant structures**

**• How piles and spread footings support heavy loads**

**• Problems that may crop up when conduit is laid in concrete during construction**

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► TODAY'S POWER-PLANT BUILDING is designed primarily to support and enclose turbine-generators, switchgear boilers and fuel-handling equipment. Grouping such equipment into a relatively small plant area always means a highly concentrated weight for the foundation. Average unit load on the soil beneath a typical modern plant falls somewhere between 3000 and 4000 psi. These pressures are higher directly under the boilers, turbines and coal bunkers. Since concrete is a common material for foundations and general building construction, let us first consider its makeup and how it is used.

### CONCRETE

Concrete is cement, sand, stone and water, mixed together and allowed to harden. To get concrete of a specified strength, care must be taken in selecting each of the materials, including the water, and then proportioning the mix.

Gravel and sand form a mass of loose particles of various sizes. Then cement is added to coat each bit of sand and stone. Water is introduced to hydrate the cement, causing the bits of sand and gravel to adhere to each other. This in a nutshell is concrete.

**Concrete Specs.** Concrete is frequently specified by either of two ways: a volume mix ratio or the desired strength. In specifying a mix by volume ratios, such as 1-2-4 or 1-3-5, we mean *one part cement or two parts sand to four parts of gravel*. More often the specification calls for concrete to be of certain minimum ultimate strength, say 2000, 3000, or 4000 psi at the end of 28 days.

When mixing concrete remember the less water used the stronger the concrete. And after pouring the concrete, the more water you use in keeping it wet, the stronger it will be. Concrete may be kept from drying out too fast by using waterproof paper coverings or water sprays. Specifications often limit the water per bag of cement to about 6 gal, for 3000 lb concrete.

About 2½ gal of water is needed to hydrate one bag of cement fully, if thoroughly mixed. But additional water is added to make concrete easier to mix and place. Added water increases *slump, a measure of fluidity of a given mix*. The greater the slump, the more fluid a mix becomes and the easier it is to place. So an irresponsible contractor is apt to use lots of water. A better way to increase slump is to add both cement and water *to keep water-cement ratio constant*.

**Concrete Tests.** To make sure concrete is of proper strength, samples are taken as it is being placed. Records are kept of where it was placed, noting the time and weather. Samples are sent to a testing laboratory. One sample of a "set" is tested at the end of seven days and another at the end of 28 days. The 7-day test is considered an indication of what to expect from the 28-day test, which is the one that must come up to specified strength. Portland cement concrete will develop about two-thirds of its design strength in the first seven days and its full design strength in 28 days. Good concrete will keep growing stronger throughout its life.

Don't pour concrete in cold weather, without protection. It freezes easily and, when frozen, hydration completely stops, so, as a result, you may have only an uncemented mass of stone and sand.

Concrete is an excellent structural material in compression, but weak in tension. So to take tension in beams, slabs, footings, and so on, steel rods are used to reinforce it. It is assumed for design purposes that all tension is taken by the steel rods used as reinforcing.

### CONDUIT

When conduit is run in concrete, keep it at least four inches from the surface. Reason is that localized heating of conduit may break the bond between it and concrete. I feel the only time conduit should be run in concrete inside a building is when there is no other way to run it. When going through floor slabs and concrete walls, use pipe sleeves larger than the conduits. Heating of bare grounding cable or conduit laid near concrete surface will result in concrete spalling. Thus the bond between cable or conduit and concrete will be broken.

When conduits must be placed in a floor slab put an additional slab atop the structural slab. This is most feasible where we have small floor areas and many conduits. It wouldn't be practical to do over a large floor area just to take a few conduits. An alternative would be conduit sleeves in the slab, then inserts in underside of slab to hang conduits. Below the basement floor, conduits may be laid directly on top of the fill and basement-floor slabs poured right over them.

**Grounding.** Pumps, motors, pipes, conduits and other mechanical and *electrical equipment may be grounded* to the building steel framework. All steel, in turn, is tied to the ground mesh or mat. More positive protection results from using a grounding cable for the complete column length. Then ground connections from this cable tie into the ground mesh.

In laying a ground mesh, one method is to lay cable directly on the ground right below the basement floor slab, stringing it along under the column lines. Then a ground lead is brazed to each column, tied to the column grounding-cable, through the floor slab and to the ground mesh. This mesh is then tied at intervals to pipes or ground rods driven 20 ft apart, 8 to 10 ft deep.

### EQUIPMENT FOUNDATIONS

Within the plant building, concrete is used mostly for building foundations, equipment foundations and floor slabs. It makes an excellent equipment foundation because of its strength and weight. Its weight, when properly used, tends to dampen the vibration of moving-equipment such as turbines, compressors, pumps, motors.

A safe rule to follow in the design of most equipment foundations is that the weight of foundation should be two to three times the total weight of machine, or three to four times the weight of moving parts. Foundation is usually a little larger than the machine bed and minimum depth is determined by weight requirements. Machine foundation is generally tied into the building slab or mat supporting it. An exception is made for large equipment like turbine-generators and pulverizers.

Here are a few design rules of thumb for turbine-generator foundations. Depth of every member, vertical or horizontal, is about one-third the length of span. Sometimes you can cut this to one-fourth the span length by using structural steel beams for reinforcing. So for an 18-ft span between bents, you should have about a 6-ft-deep beam; width about one-half to two-thirds beam depth.

Don't make square-corner intersections. Use a 12-inch or larger haunch. And for appearance, chamfer all corners.

**Soil Loads.** Almost any soil will take a spread load of 500 to 1000 psf. And if the soil is dry with much sand and gravel, or even dry clay, it will probably be good for 5000 or 6000 psf, or more. About 3000 to 4000 lb is a safe guess for average soils.

But a guess wouldn't do for a major structure. Soil investigations are almost always necessary. Adequate soil study and proper foundation design is of top importance.

***Test Methods.*** *There are two general* methods of soil investigation: visual inspection and test loading. Visual inspection calls for digging a test pit to required depth, then studying the soil. This is OK for shallow foundations and light loads.

But with deeper foundations and heavy loads, core borings are always desirable. In this test a small pipe is driven into the ground. Inside the pipe a spoon lifts the material out as the