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Quality Concrete for Swine Facilities

This NebGuide discusses the major items to consider when using concrete for swine facilities to help assure that quality concrete is obtained.

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Concrete is widely used to construct swine production facilities. Versatility, durability, and relatively low cost are characteristics that make it ideally suited for floors, walls, foundations, pen dividers, and manure storage structures. With appropriate design, concrete can even be used for the building roof and feeders. There are, however, certain major items to consider to help assure quality concrete and years of reliable service regardless of the specific use.

Planning

Planning and actual construction are equally important in assuring high quality, long-lasting concrete.

The first step in planning concrete work is to determine how the concrete will be used. This allows the most appropriate and economical mix to be selected. For example, concrete used for building footings and below ground foundation walls can use larger aggregates and less cement than concrete subjected to severe wear, weather, or manure.

The intended use determines the thickness required. The load carrying capacity of on-grade slabs varies with slab thickness, which influences site grading and concrete ordering. A 4-inch thick slab is generally

sufficient for light duty loads such as cars, pickups, light tractors, livestock, and manure storage floors. A 6-inch slab will handle most medium duty farm loads such as straight trucks, feed wagons, and most other equipment. Special design considerations are required for unusually heavy vehicles, high volume traffic, and reinforced concrete for building walls and manure storages.

Planning also includes making arrangements to have all necessary equipment and sufficient labor available during the entire project. Decisions made while the ready-mix truck is waiting in the driveway often cause less-than-ideal end results.

Site Preparation

The construction site and the area where the concrete is to be placed should be well-drained and free of standing or flowing water. Access to the site by ready-mix trucks is a necessity.

Varying amounts of site preparation may be required. In many cases the concrete can be placed directly on undisturbed soil. In others, the area must be built up to achieve the desired grade or good drainage.

Uniform density of the soil or other material below the concrete is a key to good performance of the finished job. Avoid hard and soft spots to minimize uneven settling that will result in excessive cracking of the concrete. Remove all organic matter such as grass, weeds, wood, and manure, as well as pockets of soft or muddy soil. *Never place concrete on frozen or muddy ground.*

Forming

Generally, 2 × 4 or 2 × 6 inch lumber is used as forming for slabs. Plywood is often used to form walls and pen partitions. A variety of steel and special forms are also available for specific applications. With appropriate soil conditions, concrete footings and manure pit walls can sometimes be cast in excavated trenches without forms. This technique requires a somewhat greater thickness of concrete than a formed wall due to the possibility of the concrete and soil mixing, giving lower quality results. As a general rule, add one inch of thickness to the minimum design requirements for each surface cast directly against soil.

Fresh concrete exerts tremendous pressure on the forms. Adequate staking and bracing are essential to minimize bowing and prevent form failure. Stake slab forms at least every two feet. Drive or cut off stakes flush with the top of the forms to facilitate screeding. Always check forms after bracing to assure that the correct dimensions have been maintained.

All slab edges should be thickened. This is especially important where vehicles will be driven on and off the finished slab. Thickened edges (*Figure 1*) reduce stresses in the concrete, minimizing crumbling and breakage.

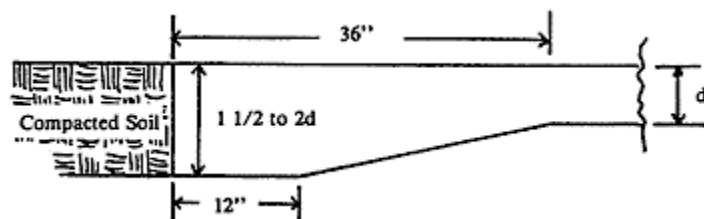


Figure 1. Thickened edge of slab.

A good construction technique for all buildings is to use a footing and foundation wall. In addition to minimizing potential slab damage due to vehicular traffic, foundation walls and footings reduce rodent problems by preventing access to the space beneath the floor.

A 3-inch thick layer of compacted coarse sand over a 6-mil polyethylene vapor barrier will prevent moisture migration through floors in facilities where a dry floor is essential. The sand reduces the risk of

damage to the polyethylene during concrete placement. Moisten the sand slightly prior to concrete placement. Avoid excess water in the mix and excess working of the concrete when using an underlying vapor barrier to prevent blistering and cracking of the slab surface.

Ordering

Before ordering concrete, check the weather forecast to decide if hot or cold weather precautions need to be taken. Ideal temperatures for placing concrete are between 50 and 90°F. Setting time shortens as temperatures increase; reduced temperatures lengthen setting time.

Good quality, long-lasting concrete requires the proper amount of cement per cubic yard and careful control of the water-to-cement ratio. Air entrainment is also desirable for most agricultural applications. The appropriate amounts depend on desired strength, consistency, workability, and other properties, such as resistance to abrasion from frequent scraping and to manure acids. For general use in swine housing, using a maximum aggregate size of 3/4 in., the following ranges are recommended:

- *Cement*--5 3/4 to 7 sacks or 540 to 660 lbs per cubic yard of concrete.
- *Water*--4 to 5 3/4 gallons per sack of cement.
- *Water to cement ratio*--0.35 to 0.50 (weight basis).
- *Air entrainment*--5 1/2 to 7 1/2 percent.
- *Minimum compressive strength*--footings and foundations, 3000 psi; walls and floors, 4000 psi.

A high water-to-cement ratio causes a weaker, less durable and less watertight concrete. Both the water and cement can be increased for improved workability as long as the ratio is not changed. Air entrainment increases concrete durability and freeze- thaw resistance.

Give the ready-mix supplier detailed directions to the jobsite. If the driver gets lost, valuable working time is wasted and concrete quality may be reduced. Indicate any special trucking restrictions such as low load limit bridges and underpasses that must be avoided. Describe the jobsite conditions as to any height, weight, or width restrictions, as well as ground conditions and any other important factors. Indicate the desired time interval between loads.

Placing

Forms need to be in place and all necessary equipment on hand when the concrete truck arrives at the site. This includes shovels, wheelbarrows, screeds, vibrators, floats, and finishing, joining, and edging tools.

Place concrete as close to its final position as possible. Do not place it in large piles which must be leveled. Avoid raking and excess movement since the aggregate and cement paste may separate.

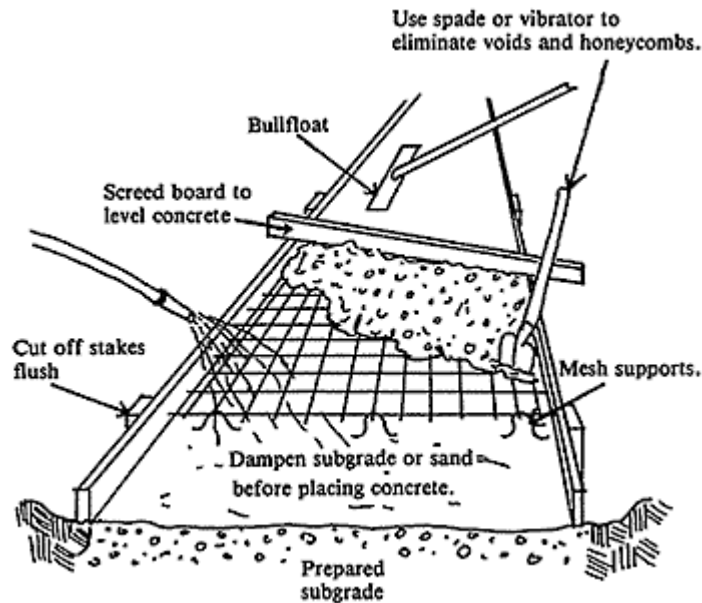


Figure 2. Screed board and bullfloat for striking off concrete.

Use a sawing action and a screed board moved along the forms to strike the concrete to the top of the forms (*Figure 2*). Always maintain a small amount of concrete ahead of the screed.

Do not add extra water to the concrete. The extra water increases the water-to-cement ratio, which substantially reduces strength and durability. The excess water must also evaporate from the concrete leading to the formation of shrinkage cracks. With few exceptions, concrete that flows readily or "pours" has too much water and should be rejected.

Bullfloating immediately after screeding is the last step in concrete placement for slabs. Large aggregates are pushed below the surface and major surface irregularities are removed.

Finishing

Some concrete finishing is usually required in swine facilities. The water sheen should disappear from the surface and concrete be allowed to stiffen before finishing is attempted. Usually finish floating can begin, and joints and edges can be tooled, in about 15 minutes to an hour after placement. Never float, trowel, or tool when free water is present on the surface. This increases the water-to-cement ratio at the surface, creating a weak layer where strength and durability are needed most. Never wet the surface to facilitate any finishing operation.

Finish floating with a wooden or metal float to remove slight imperfections is frequently used as a final finish. It provides a good slip-resistant texture and is satisfactory for growing/finishing and gestation pens. Floating also prepares the surface for subsequent finishing operations.

Troweling follows floating when a smooth, dense surface is desired, such as for floors in nursery pens, creep areas, and offices. Timing is important in this operation. Troweling too early will produce a non-durable surface. If delayed too long, the surface becomes too hard to trowel. Several trowelings may be desirable, but never trowel enough to produce free water at the surface. The surface stiffens with each successive troweling, so smaller trowels and increased tilt of blade are necessary.

Brooming following floating is a finishing operation that produces a gritty, slip-resistant surface. It

should be timed so the concrete is sufficiently hard to maintain the rough scoring. A light broom or magnesium float finish is desirable in breeding pens and the sow area within a farrowing crate. About 24 hours after placement, lightly "sand" the surface with a concrete brick to remove small projections of concrete.

Grooved finishes or aluminum oxide chips troweled into the surface layer can be used to provide slip-resistant surfaces in walk-ways. Always place in the same direction as the floor slope to assure good drainage and prevent standing water.

Jointing

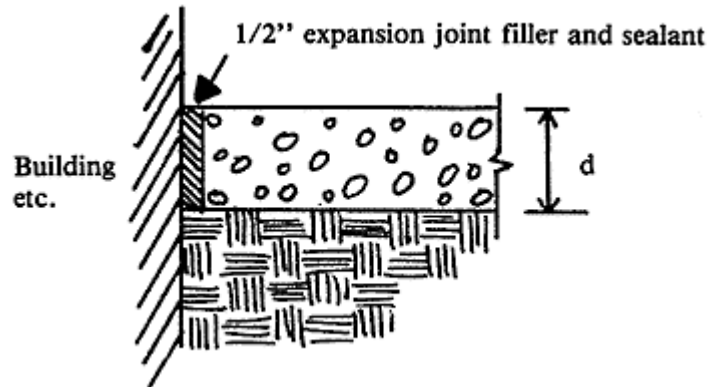


Figure 3. Isolation joint.

Incorrect jointing practices are a major problem in flatwork or slab construction. This leads to uncontrolled or random cracking, and a poor quality job. Three types of joints are commonly used: *isolation*, *control*, and *construction*.

Isolation joints (Figure 3) are used to separate slabs from fixed objects such as walls or posts. This allows the slab to move in relation to the fixed object. The joint is formed by putting isolation joint material, such as asphalt impregnated fiberboard or expanded polyvinylchloride (PVC) foam, around the object and casting the concrete to it. The isolation joint should be capped with a pliable sealant after initial concrete curing.

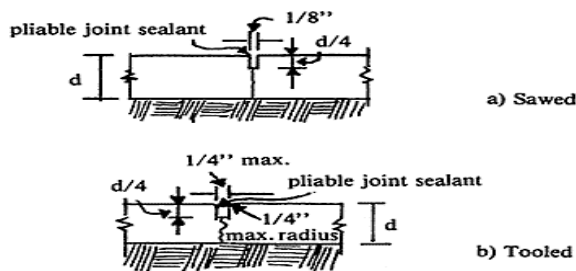


Figure 4. Control joints.

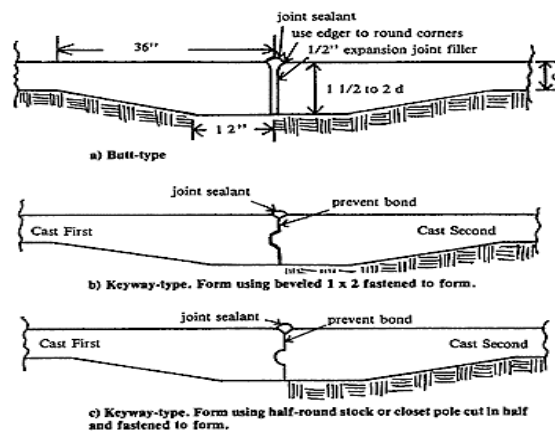


Figure 5. Thickened edge construction joints.

Concrete shrinks slightly as it loses moisture during curing. After hardening, changes in temperature and moisture content cause expansion and contraction, leading to cracking. *Control joints* (Figure 4) are

purposely placed in the concrete to encourage cracks to develop in predetermined locations. Spacing between control joints depends on slab thickness (8 feet for 4-inch slabs, 12 feet for 6-inch slabs) and should not exceed 15 feet. To help assure that cracks develop at the joints, tool or cut the slab to a depth of one-quarter of its thickness. Don't cut all the way through the slab.

When control joints cannot be used, steel reinforcing (either bars or welded wire mesh) should be used. Mesh reinforcing does not eliminate cracking. Frequent small, random cracks will still develop. However, the mesh helps hold these cracks together and the individual segments in position. Where greater control over cracking is required, use carefully placed reinforcing bars. Proper design is essential.

Use extra care when using reinforcing mesh to locate it uniformly at the center of the slab. Mesh in flat sheets, rather than roll form, is easier to position properly and is recommended. Once in place, do not walk on the mesh to avoid pushing it out of position. Do not pull or push the mesh into position through the concrete. Use commercial reinforcing chairs or supports to assure proper positioning.

Construction joints (Figure 5) are used where work is stopped for a period of time and to minimize cracking between adjacent slab sections. If possible, make construction joints coincide with control joints. When movement of one slab section relative to another cannot be tolerated, use a key-way or reinforcing bars to help maintain joint alignment (*Figures 5b and 5c*).

Use an edger adjacent to the forms. Edging increases the consolidation and strength of the edges, and aids in form removal. When correctly used, an edger produces a more attractive rounded edge, which is less severe on tires and livestock, and reduces concrete edge crumbling.

Curing

Concrete does not "dry"—it hardens by hydration which is a chemical reaction between the water and cement. Before concrete sets (initial hardening) extra water should be avoided. After setting, water is beneficial to the completion of the hydration process, which generally continues for more than a year.

Curing is the process of maintaining the proper conditions of moisture and temperature of newly cast concrete. The extent to which this process is carried out affects the durability, strength, water tightness, wear resistance, volume stability, and freeze-thaw resistance of the concrete.

Curing is often overlooked even by many professional builders. It costs very little and is a key to long lasting concrete. Curing times should be as long as possible since concrete continues to gain strength as it cures. For most agricultural applications, initial curing times of five to seven days are usually practical limits. Final curing takes place during use.

Commercial curing compounds, polyethylene plastic sheets, and waterproof building paper are ways of sealing in mixing water to enhance proper initial curing. Water mist, dampened burlap or straw, and flooding are methods that enhance initial curing by supplying additional water. Keep the concrete continuously moist during initial curing.

Temperature is also a requirement for proper initial curing, with 73°F being ideal. Between 50 and 90°F is a practical temperature range. Newly placed concrete should not be exposed to temperatures below 40°F for at least a week. Use insulating blankets, straw, or heated enclosures in the winter. Only vented heaters should be used since carbon dioxide (CO₂) from unvented heaters can cause a non-durable, chalky surface that is highly prone to dusting. Sun shades, white curing compound, and evaporating

water can help hold down temperatures in the summer.

Summary

Concrete is an excellent construction material for swine facilities. A successful project is usually assured by paying careful attention to planning, site preparation, formwork, concrete ordering, placing, finishing, jointing, and curing. If these details are neglected, it is possible to end up with a project which can be a source of problems for many years to come.

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