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ATTACHMENT T
CONCRETE MARKS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT T: CONCRETE MARKS

(From NGS OPERATIONS HANDBOOK and
MANUAL OF GEODETIC TRIANGULATION, S.P. 247)

1. CONCRETE CHARACTERISTICS

1.1 GENERAL - Concrete should have properties that make it workable, strong and durable. Workability refers to the ease with which concrete can be effectively placed, consolidated, and finished, while remaining free from segregation. Workability depends on the proportions of the ingredients and the shape of the individual particles of aggregate. Strength refers to the ability to withstand external forces without rupturing. For survey monuments, high strength is not the most important property, although strong concrete usually indicates that it is durable. Durability is the ability to withstand deterioration over a long time and is primarily influenced by the watertightness of the cured concrete.

1.2 DESTRUCTIVE FORCES - Several forces can lead to the weakening or deterioration of concrete. The freezing of water in cured cement exerts great pressure against the inner walls of the pores, tending to break down the concrete. In fresh concrete, the expansion of freezing water breaks the bonds developing between solid particles, making the concrete weak and porous. Leaching and chemical attack also have detrimental effects on concrete. Leaching occurs over a long period when water slowly percolates through concrete and dissolves some of its constituents. Chemical attack is particularly common in alkali soils. Dense, impervious concrete is resistant to these destructive forces.

1.3 INGREDIENTS - The quality of the ingredients and their proportions help determine how dense and impervious the cured concrete will be. The ingredients include aggregate, cement, and water. The aggregate should be clean (free from silt and clay, harmful chemicals, and organic matter) and well-graded, i.e., it contains proportionate amounts of many particle sizes. In specifying mix proportions the aggregate is usually divided into two parts -- sand (particle size less then 2/3 cm) and gravel (particle size greater than 2/3 cm). Both parts should be well-graded. Aggregates that are porous, split easily, or are otherwise weak or permeable result in poor concrete. Examples of poor aggregates include shale, claystone, sandstone, and micaceous rocks.

Portland cement is designated by one of five types. Type I is for general use where no special properties are needed. Type III is a high-early-strength type for use when concrete will be curing during cold weather. Type V is used where the concrete will be subject to an alkali environment. Types II and IV are not suited for setting marks. Local concrete companies should be contacted to determine the best concrete type to use in the work area.

The water used in a concrete mix should be relatively free of impurities such as acids, alkalis, salts, oil, organic matter, and silt. These can decrease the strength and durability of cured concrete. As a rule, do not use water that you would not drink.

1.4 MIXING, PLACING, AND CURING - Pre-mixed concrete materials may be used. If raw materials are used, the suitable proportions (by bulk volume) of cement to sand to gravel are 1:2:3. If the gravel is made up of fragmented or angular particles, use a little less gravel and

proportionately more sand. Add only enough water to make the mix workable. About half the water added to the mix is used in the chemical reaction (hydration) that causes the paste to harden into binder. If too little water is used, however, the mix will not compact properly and spaces will be left in the mass. **A good indication of the right amount of water is that the mix neither runs nor falls off the shovel but sluggishly slides off and flattens upon hitting the ground**.

1.5 COLD WEATHER PRECAUTIONS - The freezing of fresh concrete has a damaging effect because the expansion of water as it freezes separates the solid particles in the mix. This reduces the strength of the bond and makes the concrete more porous and correspondingly less durable.

Three protective measures should be taken in cold weather, either singly or in combination. First, use warm ingredients. During the first 24 hours after a mix has been placed, it develops little heat of its own to prevent freezing. After 24 hours some heat is developed as a product of the chemical reactions occurring in the mix. The use of warm ingredients is especially beneficial during the first 24 hours. Note, however, that mixing water above 165 degrees F could cause a flash set. To keep the aggregate and cement warm, store them indoors.

Second, use Type III (high-early-strength) cement or special additives that speed curing. Calcium Chloride is good for this in amounts not exceeding 2 pounds per 94-pound sack of cement. The Calcium chloride should be dissolved in the mixing water instead of mixing it with the other ingredients. Other additives include Thoroguard and Trimix. If a large number of concrete marks are being installed by mass production using a "ready-mix" contractor, fast-curing additives should not be added until the concrete is delivered on site.

Third, insulate the finished mark for a week after the concrete is poured. One method is to cover the mark with boards resting on supports. This is covered with paper or plastic, then by a layer of straw, Styrofoam, or similar insulating materials above 15 centimeters thick and finally by a layer of soil 15 to 30 centimeters thick. Pile snow loosely on top if it is available.

2. CONCRETE MONUMENTS (Note: portions of this paragraph apply to concrete collars around rod marks as well as to concrete monuments.)

2.1 STEPS:

1. Obtain property owner permission prior to proposing new mark locations.

2. Install a tall stake (lath) at each proposed site for a new mark. Write the proposed station name on the stake.

3. Obtain clearance from "MISS UTILITY" type services (underground utilities) before digging.

4. Drill or dig a 12 - 14 inch diameter hole in the ground 4.0 to 8+ feet deep. The depth depends on frost penetration in that area. The minimum depth is 4.0 feet. Keep the sides of the hole as smooth as possible. The rounded, bottom portion of the monument

must extend at least one foot below the frost line. See NOAA Manual NOS NGS1, *Geodetic Bench Marks* which contains a diagram showing average frost line depth.

5. Enlarge the bottom portion of the hole using a shovel such as a "sharp-shooter" (also called "drain spade") so that the hole is at least 2 inches larger in radius than the main shaft of the hole. This will make the bottom of the monument bell-shaped; see diagram.

6. Remove or tamp down the loose dirt at the bottom of the hole.

7. Remove any loose dirt that might fall into the hole during concrete installation. A layer of loose dirt from the sides or top of the hole, mixed with the concrete will create a fracture line (or plane) which could lead to the monument breaking, thus destroying the mark.

8. Procure a round, cardboard form 12 inches in diameter to line the top 12 - 18 inches of the hole. Test fit the form in the top of the hole. This form will help avoid any shoulders or mushrooming effect near the top of the monument which might afford purchase for frost heave. The form will also help make a neater looking monument. A cardboard, biodegradable, 12-inch diameter form is commercially available. Allow the form to protrude from the ground 2 - 6 inches.

9. Mix the concrete well before it is placed, otherwise the minute particles of cement will not be sufficiently wet and the aggregate will not be completely covered with paste. Prior to adding water, mix the ingredients well. Then, slowly add water and continue to mix. Do not make the mixture too wet.

10. Dampen the hole before concrete is added so moisture will not be drawn from the fresh concrete into the surrounding soil. In no case should it be so wet as to be muddy

11. Place concrete in the hole. Continuously tamp the mix into a compact mass so it becomes less pervious and consequently more durable. Do not contaminate the interior of the monument with dirt.

12. Place the form into the hole when the level of the concrete is approximately one foot below the surface. Continue to be careful not to allow any dirt to fall into the hole.

13. Add concrete until the top is even with or slightly below the surface of the ground. This helps ensure that the monument is not struck by lawn mowers or snow plows, etc.

14. Smooth off the top of the monument with a trowel. Create a gentle slope towards the outside so that rain water will drain off. Bevel the outside edge of the monument.

15. Stamp the disk prior to installing it in a concrete monument or a drill hole. Stamp the disk on a stamping block which has a curved surface that matches the curvature of the underside of the disk. Neatly stamp the station designation (name) above the triangle, centered below "HORIZONTAL CONTROL MARK" and then stamp the year below the triangle, centered above "THE DIRECTOR".

16. Set the disk into position in the top center of the monument with the top of the triangle below the name pointing north (so that a visitor facing north will be able to read the disk's lettering). Placing a small amount of concrete on the underside of the disk before setting helps ensure that air is not trapped under the disk.

17. Press the disk into the concrete until the disk edge touches the concrete. Then tap the disk with the handle end of the trowel **until the top edge of the disk is flush with or slightly recessed into the concrete** (to the point that vandals can not get a pry bar under the disk). Do not recess the disk a greater amount because this makes a hollow that will collect rainwater and possibly shorten the life of the mark due to freezing action.

18. Clean the disk. Sprinkle some dry cement on the exposed surface of the disk, then rub it with a clean rag or short bristled brush using circular strokes. This will clean the disk, removing all excess mortar from its surface and recessed letters. Rubbing the wet mortar around the edge of the disk in the same manner is done intentionally to finish its surface and help prevent cracking. Brush away loose cement and make sure that the finished product has a neat appearance.

19. Cover the mark for at least 7 days. This prevents rain from making the mix too wet and from ruining the finished surface. It also prevents the surface from drying too rapidly, leaving too little water for complete hydration. In addition, it prevents debris from sticking to the surface of the wet concrete. A 12 inch diameter lid is available that fits on the 12 inch cylindrical form. This lid will also keep out the dirt during the next step and final clean-up.

20. Replace dirt around the form and tamp into place. At the surface, replace dirt and sod around the form and tamp into place.

21. Rake the area until neat and remove excess materials. Do not leave any construction or other materials at the site. Leave the area as neat as or neater than when you arrived. Note: the protruding form and lid shall be removed later during survey observations.

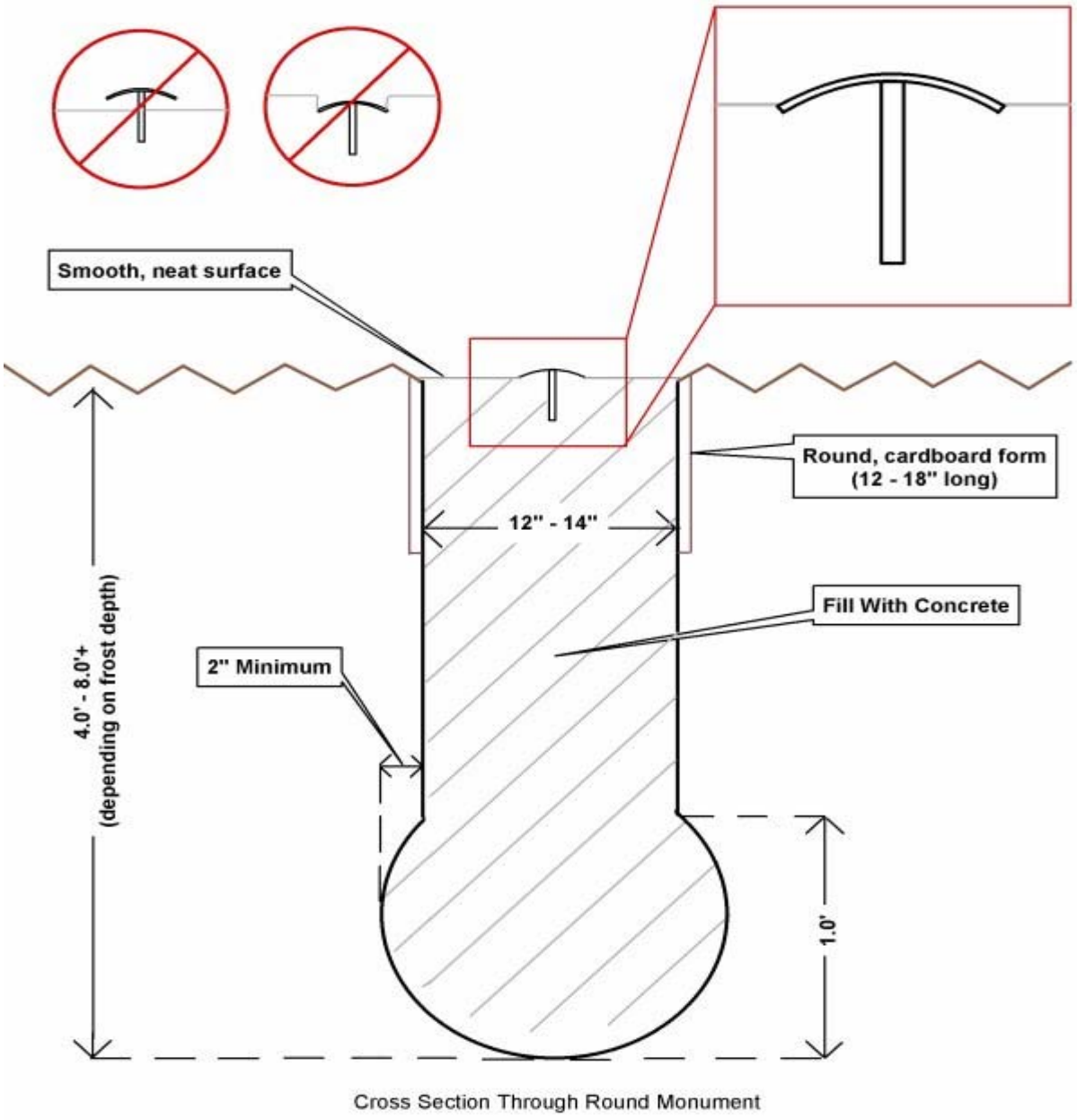
22. Remove excess dirt and dispose of it properly. In some rural areas there may be a logical spot to dump the extra soil where no one will notice. If the mark is in an area consisting of groomed lawns, the dirt shall be removed from the site.

23. Remove excess concrete from the site. Proper planning should minimize excess concrete. Any excess shall not be dumped on-site.

24. Installation of NGS Witness Posts is at the option of the firm. Generally do not use Witness Posts in areas of high population density nor on airports. They are very useful to future surveyors in more remote areas.

25. Do not add magnetic materials to the monument.

Standard NGS Concrete Monument



Cross Section Through Round Monument