**Commentary on Waterjetting**

Waterjetting is allowed by the Standard Specifications to be utilized at the contractor’s discretion. This commentary discusses the use of waterjetting and the implications for pile design and construction.

The basic principle of waterjetting is to locally disturb, erode, liquefy and weaken the soil around and directly beneath the pile tip. In granular soils where resistance to driving is predominantly from the buildup of a pressure bulb at the pile tip, this amounts to locally increasing the pore water pressure at the pile tip and thus reducing the internal shear strength of the soil. In cohesive soils where resistance to driving is predominantly from the adhesion of the soil along the sides of the pile, this amounts to the creation of returning water flow to the surface along the sides of the pile creating a lubricating effect and thus reducing the amount of adhesion. In general, total resistance to driving by reducing the frictional resistance along the sides of a pile and the end bearing resistance at the tip of a pile.

Significant advantages of waterjetting include primarily the time savings by reducing the drivability resistance which allows for more piling to be driven quickly. Secondary advantages could include the ability to drive long piles, the possible use of smaller hammers or a reduction in ground vibrations during driving which could be important in vibration-sensitive areas.

Significant disadvantages of waterjetting include the loss of geotechnical strength and quantifying the presumed changed strength resistances of the soil created by the process itself. On the construction side, there are the field complexities associated with controlling the water pressure during driving, water runoff from pump discharges including erosion and turbidity control issues.

The implications of waterjetting on pile design are important when incorporating CIP pile design into a job. The effects of waterjetting with regard to quantifying the associated post-response geotechnical pile resistance and soil resistance reductions are not well documented; phenomenologically, it is understood that pile advancement which is obtained through the destruction of side and end bearing resistance could cause a permanent reduction in the soil strength parameters both axially and laterally which should be accounted for in pile design. Of lesser consequence may be that structural pile strength could be affected if lateral support is reduced.

But, most significantly, the practice of waterjetting CIP piles is left to the discretion of the contractor in accordance with Standard Specifications Sec 702 at the time of driving. This means that the effects of waterjetting, if any, are unaccounted for at the time of pile design. Therefore the dual problem exists of not only how to account for waterjetting but when to account for the potential of waterjetting which must be established first. Alternatively, not allowing waterjetting may be done by noting on the plans.

When waterjetting is to be utilized, it is required that it be used in combination with a pile driving hammer in order to advance the pile quickly and ultimately to determine the nominal axial compressive resistance of the pile using dynamic formula.

CIP Pile Design

1. Using standard pile friction and end bearing static design methods with unadjusted soil strength parameters is questionable. Some adjustment would seem to be in order to define actual soil conditions presumed at the time of driving which may or may not represent long term state of stress for soil. It is likely that some restoration may occur.

2. The argument that the final positioning of CIP piles is required to be set by driving without waterjetting is satisfying but cannot completely dispel the notion that strength is somehow compromised, if not at the tip of the pile then certainly along the sides of the pile. However, resistance measurement is required by dynamic formula or dynamic analysis which will produce a quantifiable nominal axial compressive resistance of a pile which should be equal to or greater than that shown on the plans.

3. An allowance for a decrease in soil shear strength or other soil strength parameters may be in order.

4. If structure is critical, it may be necessary to provide two pile solutions. One pile solution would be the pile design and length driven by hammer only. The second pile solution would account for waterjetting using changed soil strength parameters due to waterjetting for design of length of pile.

5. Waterjetting should not be allowed for placing CIP piling in seismic regions due to the possible eroding away of fines along the length of the pile which would reduce lateral load resistance of pile/soil system.

6. Consult the Geotechnical Section to request an evaluation of the soil type supporting proposed CIP piles and a recommendation on waterjetting or other methods for driving long CIP piles. Geotechnical Section could provide control elevations, or elevations where jetting may be used, i.e. layers of hard material that need to be penetrated, if necessary. Soil strength may need to be reduced to best represent presumed permanent static soil conditions after waterjetting. Dynamic formula results do not need to be adjusted but it must be realized that pile lengths may be greater than planned lengths due to waterjetting and a reduction in pile driving resistance.

7. Alternatives to waterjetting include requiring conical pile tips, predrilling holes and spudding. Predrilling should be sized less than diameter of CIP piles for maintaining side friction resistance.

A red outlined box indicates practice that is common (or allowed).

**Flowchart: Placing CIP Piles**