GRUNDFOS

INTRODUCTION

This White Paper for concrete foundations for heavy-duty pumps, is intended to assist pump station designers, planners, application engineers, consulting engineers and users of pump stations incorporating Grundfos wastewater pumps. The recommendations are meant as guidance in connection with installation of pumps in concrete pumping stations. Installation of dry-installed pumps in prefabricated fiberglass and composite tanks, where special conditions must be taken in to account, is not covered by this White Paper. For installation in fiberglass and composite tanks the producer's installation guidance should be followed.

FOUNDATIONS

Although a baseplate is designed to be a rigid support for a pump and its driver, it will deflect. For this reason, a foundation may be provided for additional support. One of the most significant factors for a reliable and trouble-free pump installation is a good foundation.

Other factors of a good installation are the baseplate, its installation, and the alignment of the equipment.
Other White Papers by Grundfos discuss these topics. This White Paper focuses on good industrial practices for pump foundations, but the installer should refer to the requirements of the manufacturer or owner.

All rotating equipment will generate vibrations when turning at high speed, in case of unbalance on a rotating part. Pump unbalance will most often come from manufacturing tolerances of the impeller, shaft and rotor. Another source of vibrations in pumps is hydraulic pulsation, primarily generated by impeller vanes passing the volute tongue. Single channel impeller pumps, most often used in wastewater applications, generates most hydraulic pulsation which causes vibrations.

Especially in wastewater applications where there is a risk for partly or full blockage of impeller resulting in unbalance, a rigid foundation is an absolute necessity. In such situations the equipment will vibrate heavily above the normal level and it is important that the foundation and the structure can handle such a situation for shorter periods.

WHITE PAPER

FOR CONCRETE FOUNDATIONS

Figure 1 shows a Grundfos horizontal dry-pit solids handling pump with electric motor, mounted on a common baseplate.

Figure 1. *Grundfos horizontal dry-pit heavy-duty sewage pump series 7100.*

This entire unit has been grouted to a foundation for a durable installation.

Another key purpose of a good foundation is to help maintain alignment between the pump and motor. Alignment is also critical to the reliability of the equipment.

Without a good foundation, distortion of the baseplate may occur due to the ground settling, thermal distortion of the baseplate, excessive piping forces, and pressure or vacuum forces that occur because of expansion joints.

This may cause the pump and driver to become misaligned, and reduce the reliability of the rotating equipment.

DESIGN RECOMMENDATIONS

The foundation should begin with a firm footing. Fabricating a concrete foundation from the solid ground is the most acceptable. Concrete is the best material for construction of foundations because it is low in cost.

The mass of the concrete foundation shall be great enough to absorb any of the dynamic and static forces previously described.
The Hydraulic Institute recommends in its Standards Ref.1 that the mass of the concrete foundation should be about three - five (3-5) times that of the equipment it is supporting.

If the pump unit is mounted on other than concrete foundation, such as a steel structure, the base should be supported on rigid steel beams along its length. It should also be mounted as near as possible to main structural members, other beams and the surrounding walls.

Calculations should be made on the steel structure to ensure that it has adequate rigidity to minimize baseplate distortion and vibration during operation.

The Hydraulic Institute also recommends in its Standards Ref.2 that pump units may be fastened directly to an existing concrete floor if the floor meets the criteria of a foundation. In Figure 2. Grundfos horizontal submersible dry-pit sewage pumps with slide rails are fastened to the floor.

If this is done, installation of threaded bolts into the foundation can be done as shown in Figure 3. This provides a rigid installation.

The rails should be properly installed on a soleplate that are mounted on a foundation and grouted into place.

Proper grouting of rails requires many recommended practices; however, one should always follow the instructions and recommendations of the grout manufacturer. The instructions may differ between an expanding grout and a non-shrink grout.

Figure 2. *Grundfos dry-pit submersible sewage pumps.*

Typically, the grout should be poured when the ambient temperature is between 10° to 32° C (50° to 90° F). This will provide a good consistency in the grout. It should be mixed to a water-like consistency to allow it to flow evenly within the soleplate or baseplate and for all air to be expelled from the vent holes in the plate compartments.

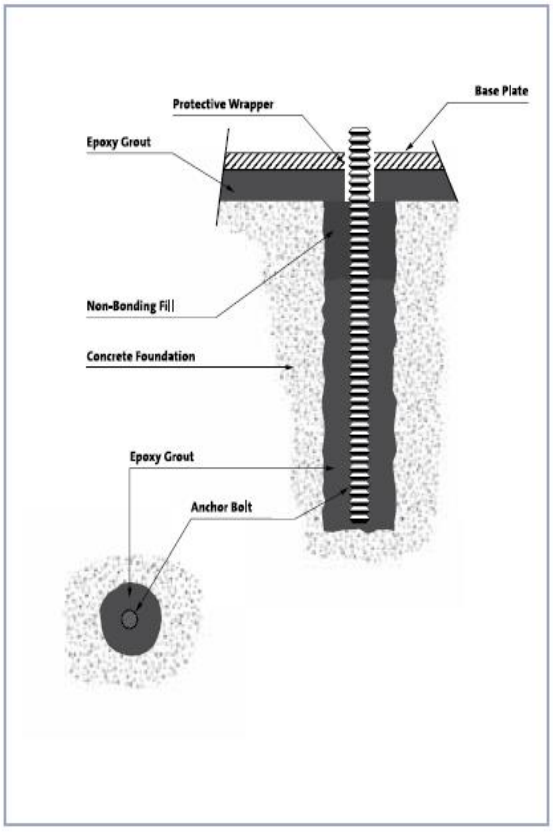


Figure 3. *Treaded anchor bolt in foundation*

The depth of a concrete foundation should reach through the concrete flooring or elevation to solid ground or footings. The height of the foundation above the elevation is as required by the piping layout, but at least 20 times the diameter of the foundation bolts.

The foundation should be produced as an independent foundation without contact to the surroundings. For the disconnection between the foundation and the solid ground and other building constructions Sylomer should be used.

Sylomer is a special PUR elastomer used in a wide range of applications in construction and mechanical engineering to dampen vibrations.
The Sylomer shall be placed in the bottom and on the sides of the excavation before the concrete pouring. The foundation shall be done so that the Sylomer is intact up to the final floor level.

The Sylomer is selected based on the foundation mass to secure a low natural frequency <0.8 x rpm in proportion to the minimum revolution for the pump.

General industry practice provides a foundation that is 8 cm to 15 cm (3 to 6 inches) longer and wider than the baseplate that will be installed for horizontal end-suction pumps with flexible coupling and pumps where the pump and motor are build direct together.
A practice of the petrochemical industry provides a design that ensures the foundation is wide enough to provide a rigid support.

This practice draws imaginary lines downward 30° on either side of the vertical of the pump, through the shaft centerline. These imaginary lines, as seen in Figure 4, should pass through the bottom of the foundation, not the sides.

The foundation should be 15 cm (6 inches) wider and longer than the baseplate for pumps up to 350 kW and 25 cm (10 inches) for larger pumps.

The concrete used in the foundation should have a minimum tensile strength of 250 N/cm2.

For vertical pump installations, similar to that shown in Figure 5, where pump and motor are build direct together. The size and mass of the foundation must be maximized to ensure the best possible rigidity.

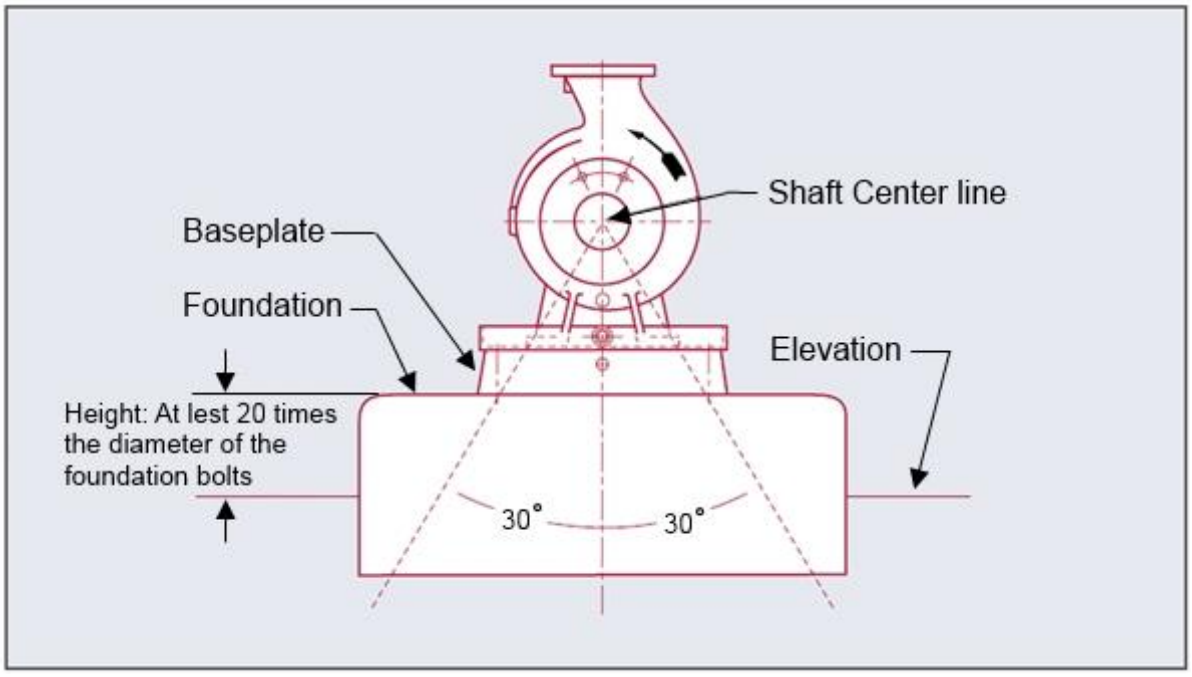


Figure 4. *Foundation design*

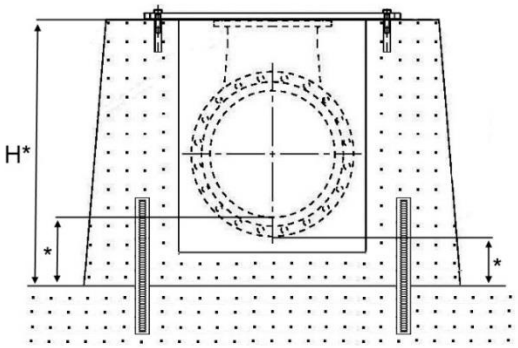
Pins to floor or footing

Figure 5. *Grundfos vertical dry-pit submersible sewage pump*

If a new pump unit is being installed in place of an existing unit, the existing foundation should be removed in its entirety. The removal should be total and allow the new concrete foundation to reach to the solid ground or footing.

In some cases it can be difficult to establish a foundation with a mass (3-5) times that of the pump unit. Therefore the new concrete foundation should be reinforced with pins to the floor, and thereby make the floor an active part of the foundation.

The floor and the concrete foundation should be of adequate strength to support the weight of the pump with pipes and valves plus the weight of the liquid passing through it, and the forces generated by the pump.

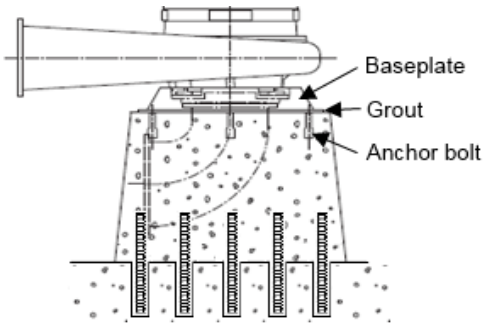


Pins to floor or footing

Figure 6. *Minimum required space for piping and suction elbow.*

The overall height of the foundation should be as low as possible but still allow space for piping alignment and space between the suction elbow and the floor.
See details in figure 5, 6 and 7.

The length and width of the concrete foundation should be sufficient to meet civil engineering design standard and local codes.



Pins to floor or footing

Figure 7. *The opening between the plinths should allow for proper clearance of the inlet elbow flange at the pump suction and mounting bolts.*

These foundation bolts are embedded in the concrete foundation. To assist in the proper location of the bolts and to maintain their position when pouring the foundation, a template can be formed.

Pipe sleeves are used to allow final positioning of the bolt. These sleeves are a minimum of 3 times larger than the bolt, and have a length of at least 10 times the diameter. Figure 8 provides a view of the anchor bolt and pipe sleeve in which it is installed.

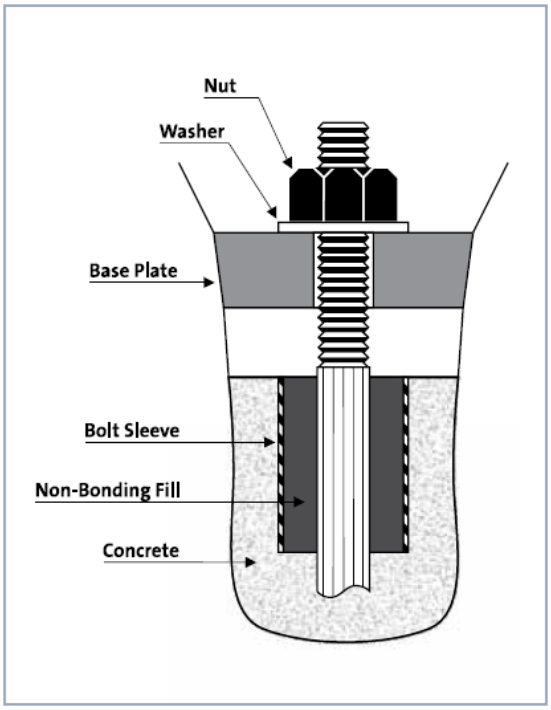


Figure 8. *Anchor bolt and pipe sleeve detail*

INSTALLATION RECOMMENDATION

Installation of the foundation is critical to the life of the pump unit. Best practice recommends that all equipment be removed from the soleplate or baseplate for pumps. This practice will mostly be done with large equipment. The bolt locations should be double-checked with drawings and base. In some cases the pump manufacture can recommend another practice.

Once the foundation is ready to pour, the exposed threads of the anchor bolts should be covered with grease or wax and then the exposed threads should be wrapped.

The foundation bolt sleeves may be packed with some type of non-binding material, such as rags or grease, to prevent concrete from entering the sleeve and prevent a final adjustment of the foundation bolts.

Insure that enough concrete is available to complete the job all at once and follow general practice for concrete pouring like vibrate, air removal etc. The poured concrete foundation should then be allowed to cure for a minimum of 14 days. Hydraulic Institute prefers 28 days. Waxed forms assist in the removal after the concrete has cured.

Before installing the soleplate or baseplate, the underside should be cleaned and coated with an epoxy primer. The foundation should have been poured with a rough surface or should be roughed after pouring, to provide a good surface to allow the grout to bond.

Figure 9 provides a view of a typical baseplate that is grouted to a foundation. Note that the anchor bolts are not shown. It is also important that no sharp edges come in immediate contact with the grout. Sharp corners or edges may cause the grout to crack. Corners should be made round, such as those on the leveling wedges.

Figure 9. *Grundfos horizontal dry-pit sewage pumps.*

The baseplate may be provided with 1.9 cm to 3.8 cm (0.75 inches to 1.5 inches) jackscrews. These should be coated with an anti-seize compound to assist in the removal after grouting.

Final leveling should bring the pump and driver mounting pads back to the plane in which they were machined to co-planer flatness.

It must be noted that pre-cast foundations, are available. These pre-cast units are constructed of a polymer material or regular concrete that is inert to many chemicals. They may also reduce installation time for a new or replacement foundation. See Figure 10.

The mass of the pre-cast foundation should be calculated as on site concrete casted foundation and it should be great enough that it absorbs any of the dynamic and static forces previously described.

Figure 10. *Grundfos sewage pumps horizontal mounted on pre-cast foundations*

REFERENCES

1. Hydraulic Institute (2000). *ANSI/HI 1.4 – Centrifugal Operations*. Hydraulic Institute, 9 Sylvan Way, Parsippany, NJ 07054. http://www.pumps.org.
2. Hydraulic Institute (2000). *ANSI/HI 3.1-3.5 – Rotary Pumps*. Hydraulic Institute, 9 Sylvan Way, Parsippany, NJ 07054. http://www.pumps.org.

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