Precast Polymer Technology is a Game Changer for Pump Base Foundations
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By: Thomas Kline - Director, Concrete Repair Solutions

Introduction

In an effort to reduce pump installation costs as well as improve pump reliability, maintenance & reliability professionals are turning to precast polymer concrete pump foundations. This proven foundation technology provides many advantages over conventional pump foundations. Advantages include installation cost savings, improved corrosion resistance in aggressive environments as well as improved overall reliability.

Polyshield\textsuperscript{®} precast polymer concrete foundation systems consist of a foundation baseplate shell for rotating pumps and motors (Figure 1). The foundations are constructed of polymer concrete in a one-piece shell. The shell replaces the baseplate, foundation, anchor bolts and grouting system of a traditional pump foundation. The system can be combined with a variety of rotating pump designs, including ANSI\textsuperscript{I} and ISO\textsuperscript{II} pumps. Custom-built foundations can meet special pump requirements such as those associated with API\textsuperscript{III} applications.

A prime mover in selecting these types of foundation systems is when pumps are subjected to corrosive service. These foundation systems thrive in corrosive environments because they are made from inherently corrosion resistant inert aggregate-filled thermosetting resins such as novolac epoxy or vinyl ester\textsuperscript{IV}. Often however, many end users are installing these units in non-corrosive services in new construction as well as repairs or upgrades of existing pump installations for enhanced constructability reasons alone. In new construction, because the need for forming and placing conventional concrete foundations is eliminated along with elimination of anchor bolts, separate base plates, and grouting systems, the time and labor required to install a pump package is dramatically reduced. In the case of upgrade or repair of existing pump installations, it’s common to complete the upgrade or repair and have the pump back up and running within one or two days instead of 10 to 28 days associated with conventional pump foundations.
Precast polymer concrete pump foundations can drastically reduce the total installed cost compared to conventional fabricated steel baseplates. Typically, ANSI pump installation time is reduced from 10 days or more to one or two days. Craft man-hours are reduced 70 to 80% (Figure 2). Additional savings can come from the ANSI pump being mounted to the precast polymer concrete shell prior to installation. Fewer installation steps require fewer skilled craftsmen. Minimal edge forming is used, and expensive acid brick foundations in traditional foundations are avoided in corrosive service. Instead of expensive grouts, standard 3,000 psi (21MPa) concrete is used to fill the pump foundation cavity. Finally, abrasive-grit blasting is not necessary to ensure proper bonding of concrete substrates to installed protective coating/lining systems as is required in conventional pump foundations. Essentially, the precast polymer shell doesn’t require corrosion protection as the shell constituents of aggregate-filled thermosetting resins are designed for the specific corrosive service conditions.

Besides cost savings associated with the installation process, a precast polymer concrete foundation reduces overall life cycle costs. Precast polymer concrete technology improves vibration signatures for reduced downtime and related maintenance costs such as fewer seal and bearing repairs. To further improve life cycle costs, as stated earlier, a precast polymer concrete foundation offers excellent corrosion resistance due to the aggregate-filled thermosetting resin technology. Additionally, equipment MTBPM (Mean Time Between Preventative Maintenance) is improved with a precast polymer concrete foundation.

Field Labor Step Comparison

<table>
<thead>
<tr>
<th>Event</th>
<th>All Metallic Baseplates</th>
<th>Non-Grouted Pre-Grouted Polyshield® Baseplate and Foundation System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Roughen paving</td>
<td></td>
<td></td>
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<tr>
<td>2 Dowel paving and set rebar</td>
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<td>*</td>
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<tr>
<td>3 Pour pump foundation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Roughen foundation top</td>
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<td>*</td>
</tr>
<tr>
<td>5 Clean/seal anchor bolt sleeves</td>
<td></td>
<td></td>
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<tr>
<td>6 Inspect/prep pump base</td>
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<tr>
<td>7 Set base to centerline</td>
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<tr>
<td>8 Level base or Polyshield</td>
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<tr>
<td>9 Check alignment</td>
<td></td>
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<tr>
<td>10 Set form base</td>
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<tr>
<td>11 Pour first lift</td>
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<tr>
<td>12 Cleanup</td>
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<tr>
<td>13 Pour second lift</td>
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<tr>
<td>14 Cleanup</td>
<td></td>
<td></td>
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<tr>
<td>15 Check for voids</td>
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<td></td>
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<tr>
<td>16 Check levelness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Seal Polyshield foundation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Remove forms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Remove jackbolts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Fix voids in baseplate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Discrete Steps</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Craft Man-Hours Required</td>
<td>103</td>
<td>74</td>
</tr>
</tbody>
</table>

| Installation Time**           | 13 Days                 | 7 Days            | 2 Days |
|-------------------------------|-------------------------|------------------|

**Exclusive of curing time

Actual results reported by a major chemical company

Figure 2 – Polyshield® reduces installation time and man-hours

Figure 3 – Pump/motor mounted onto precast polymer concrete foundation shell prior to setting overtop of reinforcing steel bar cage

Installation Process

Installing a precast polymer concrete pump foundation is a relatively simple process, compared to traditional pump foundations. Employing precast polymer concrete technology to install a new pump foundation, a reinforcing steel bar cage is dowelled into the concrete slab or footing — as would normally be done when forming and placing a conventional concrete foundation (Figure 3). The precast polymer concrete foundation is then placed over the rebar cage, leveled and filled with standard 3,000 psi (21MPa) concrete. This installation typically requires only a few hours to complete and saves considerable time in new plant construction. The inherent rigidity of precast polymer concrete foundations, warping of the coplanar pump and motor mounting surfaces, common with steel base plates, is eliminated.
To date, precast polymer concrete pump foundations are used mostly for standard ANSI pumps and for this reason, standard-sized reusable molds are used to precast ANSI standard combination foundation/baseplate units.

It’s important to note that precast polymer concrete technology allows a further refinement of the system in formulating removable, single-piece, motor-specific precast blocks, which are bolted onto the motor end of the precast units. These motor blocks have precisely positioned specially fabricated threaded inserts cast integrally into the polymer concrete body of the block to match the bolt patterns of standard NEMA frame motors. Changing to a different-sized motor for a given pump becomes a mere changeout of precast motor blocks.

The unique characteristics of polymer concrete allow greater versatility in designs. For instance, the motor adjusting devices are favored by millwrights that facilitate motor and pump alignment in the field. Polymer concrete also allows cast-in drip catch pans with integral drain fittings to be incorporated at the pump end of the precast unit, so leaks can be collected and piped off to a collection basin or trench.

**Vibration Signature Testing**

Vibration signature testing is commonly used on rotating equipment to diagnose and predict pending failures with pump and motor operation. Readings are typically taken in three planes (horizontal, vertical and axial) and reported as velocity amplitudes in inches/second at various frequencies. It is generally accepted that the lower the velocity amplitudes on a vibration signature for a given pump system, the longer that equipment will operate before maintenance is required.

The vibration signatures observed on pumps mounted to precast polymer concrete foundations indicate that polymer concrete is a vibration dampener for rotating equipment. Velocity amplitudes in the range of 0.10 inches/second are considered desirable by rotating equipment engineers but results as low as 0.005 inches/second have been reported on signatures from pump installations on precast polymer concrete foundations. (Figure 4) (Pump and motor alignment must still be properly executed — and any pipe strain must be removed — or the signatures will not be acceptable in any case.)

The properties of polymer concrete also allow the fabrication of larger custom-made precast pump foundation/baseplate combination units for non-ANSI pumps. In fact, it is possible to fabricate units as large as 4 feet (1.2 meters) wide and 14 feet (4.3 meters) long as shown in Figure 5 with stainless steel mounting pads for the pump, and the motor integrally cast into the top. The pads are first milled flat and coplanar, then drilled and tapped for the specific pump and motor. Pump packages with motors as large as 1000 HP are successfully operating in the field on custom-made precast polymer concrete units. This technology is also successfully employed with centerline mounted API pumps.

Combining the disciplines of civil engineering and mechanical
engineering has resulted in the practical application of polymer concrete technology to provide corrosion-resistant, precast polymer concrete pump foundation systems, which are more cost-efficient and quicker to install. Over time, these new designs may go a long way toward eclipsing conventional pump support systems in refining and petrochemical facilities.

**Case Study: Petrochemical Plant Expansion**

A major petrochemical company located in the Southern Gulf Coast region of the USA was faced with the challenge of installing 90 ANSI pumps for its plant expansion. The company chose precast polymer concrete pump foundations for their ability to reduce total installation costs.

The company had previously relied on conventional pump installations and had experienced numerous problems with the traditional method. As such, the facility commonly had to remediate conventional pump installations because of warped steel baseplates. In other cases, voids formed in the epoxy grout during base plate grouting and tedious/expensive epoxy injection of the voids delayed pump start up. Finally, some base plates could be salvaged only by expensive & time-consuming field machining.

After first inspecting random ANSI precast units from inventory to insure they met coplanar and parallel flatness requirements, cost projections were then analyzed comparing precast polymer concrete pump foundations versus conventional pump base foundation installation. When the data demonstrated cost & time savings, installation of the precast polymer concrete pump foundations was scheduled for project installation.

As the precast polymer concrete pump foundations were in stock, the units were shipped to the pump manufacturer, where the pumps and motors were mounted and aligned to factory standards. Next, the pumps, motors, and precast foundations were sent as complete packages to the petrochemical plant’s laydown yard until they were ready to be installed (Figure 6).

Plant personnel marked off each place in the new plant where a pump and foundation would be installed. For each pump location, a reinforcing steel bar cage was dowelled into the concrete slab, and the foundation with pump and motor attached was then set over top of the cage. Project scheduling mandated five to six pumps at a time were to be installed and leveled. A concrete truck then filled each precast polymer concrete shell cavity with standard 3,000 psi (21 MPa) ready mix concrete. A final alignment was then performed, the piping connected which then resulted in completing the installation.

On installation costs alone, the plant saved thousands of dollars ($USD) per pump. Not only did installation go quickly, it also was performed very safely – which was another key issue for the plant. Using the precast polymer concrete pump foundation technology, pump installation reduced labor, with fewer people on site, thereby greatly reducing risk.
15 years after the installation was complete, the petrochemical plant is reaping the rewards of using the precast polymer concrete pump foundation system. The plant has not had to repair these pump foundation systems as it would have with conventional means & methods with maintenance cost savings of over 50%. Vibration signature testing shows the new pumps are vibrating much less than with traditional installations, which means fewer replacement parts and downtime. Results of the testing shows the overall velocity amplitudes at half or less than half of that of conventionally mounted pumps in the plant. The plant also has noticed its pumps running quieter, smoother and with longer time between repairs (Figure 7).

While maintenance and reliability plant personnel choose precast polymer concrete pump foundations to reduce installation costs, time has proven the technology’s capacity to continue providing savings in terms of improving maintenance costs. Whether a plant needs to install a completely new foundation or repair a damaged existing foundation, precast polymer concrete pump foundations provide a more cost-efficient and faster installation over conventional pump foundations.

References
1. American National Standards Institute (ANSI), 1899 L Street NW, Washington, DC 20036 USA
2. International Organization for Standardization (ISO), 545 Washington Boulevard, Jersey City, NJ 07310-1686 USA
3. American Petroleum Institute (API), 200 Massachusetts Avenue NW, Washington, DC 20001-5571 USA
5. National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Arlington, Virginia 22209 USA
Precast Polymer Technology is a Game Changer for Pump Base Foundations

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