A Sold Foundation for Your Investment
Company Introduction

BGA was established in 2011 with the aim of supplying Iran’s growing needs for advanced technological solutions for deep foundations and soil improvement. Within a year, BGA broke ground on its manufacturing site in Arvand Special Economic Zone (Arvand) to produce Pre-stressed High Strength Concrete Piles (PHC Piles) in addition to poles.

At BGA, our prime objective is to get a complete understanding of our clients’ needs to ensure we provide them with the best possible solution for their soil improvement needs at the lowest possible cost.

BGA is undergoing an expansion of production capacity from 250 kilometers per year to 500 within the next eight months.
Applications of PHC Piles

PHC piles were first invented in Japan in the 1970’s as a means to provide a solid base for building structures in a rapidly growing and earthquake prone country. Since their invention in Japan, PHC piles have been used widely in developed countries such as USA, Germany, Italy, as well as Korea, Singapore, Malaysia, Thailand, Indonesia, Vietnam and played a key role in rapid development of China and Southeast Asia.

In any important project, foundations and soil improvement are the first stage of development. For over 40 years PHC piles have provided the safest, fastest and most economical solution as a foundation for major infrastructure and investments.

PHC piles are most effective solutions in the following uses:

- Bridge piers as deep foundation or pier piles
- Tall Buildings
- Petroleum and gas tanks, water and sewage, waste water treatment plants
- Marine structures and harbours
- Equipment foundation solutions for petroleum, gas and steel plants
- Water desalination plants
- Hinterlands
- Liquefaction Mitigation
- Geothermal system
- Concrete cut-off walls
Advantages of using Bonyan Gostar Arvand PHC Piles

- Using BGA pile solutions means your project will be completed quickly and meet the highest international standards
- High ultimate tensile, bending and compressive strengths
- High strength during pile driving, lower susceptibility to pile head damage and higher resistance against cracking along the pile
- Higher toe bearing capacity of piles
- Stronger protection against corrosive environments and salty waters
- Easier transportation and displacement for lower pile weight
- Easy pile integrity test before and after installation
- Cost effective solution
- Better quality products for steel materials and concrete technology
- Faster and easier connection between pile section and parts
- No need of pile head breaking for connection to the foundation
SECTION 3 DESIGN REQUIREMENTS AND PROCEDURES

3.1 OBJECTIVE OF PILE DESIGN
The objective of pile design is to provide a footing that will safely support the superstructure over its design life.

3.2 GENERAL DESIGN REQUIREMENTS

3.2.1 General
The footing shall be durable, and of adequate strength, and the footing performance shall be compatible with the superstructure so that it remains serviceable and can perform its intended function. The design shall take into account, as appropriate, the following:
- Ultimate strength
- Serviceability

3.2.2 Durability Design for ultimate strength
- Single piles, pile groups and individual piles within a pile group shall be designed for both structural and geotechnical strength

3.2.3 Design for serviceability
Single piles and pile groups shall be designed for serviceability by controlling or limiting pile movements (d) including differential and total settlements, horizontal displacement and rotation.

3.2.4 Design for durability
Piles shall be designed for durability in accordance with Section 6.
Why PHC Piles?

PHC Piles have an extremely high tensile strength which avoid cracks occurring in the pile structure before and during installation (transportation and driving stages) and after installation (service loads and ground movement).

Transportation of piles as well as the tensions created during pile driving is the main cause of tensile stress. Due to the innate weakness of concrete against tensile stress, cracks typically occur in ordinary reinforced concrete pile sections.

In traditional piles, tensile strength is provided by steel rebar. Unfortunately, the reinforcing bars deform longitudinally during transport and installation and con-sequently sectional cracks are created in concrete.

In corrosive environments, these cracks lead to damage to steel and concrete by penetration of chlorine ion, Sulphates, alkaline reactions, etc. To complicate matters more, inspection and evaluation of integrity of traditional concrete piles after installation are challenging as these elements are not accessible by visual inspection.

Some consultants mainly focus on the superstructure and calculate pile structural strength and resistance, whereas serviceability load during transportation, erection and installation must also be calculated.

In section 3, Australian Standard Piling – Design and installation AS2159 emphasizes the requirements and procedures of considering serviceability loads in pile design. If superstructure loads, transportation and installation influences, seismic loads, ground movements, adhesion of soils and parameters of durability and design life mentioned in section 6 of Australian Standard AS2159 are considered, the parameters of pile design, in corrosive environments, traditional non-prestressed piles must be excluded as an option.

Centrifugally manufactured concrete creates a higher density, hardened con-crete compared to cast-in-place method making sure that no cracks are creat-ed along the shaft of the pile when pre-stressing is added. This means no damage to the piles during transportation and installation.

To summarize, prestressed manufactured piles results in very high strength con-crete guaranteeing the durability and design life of piles after installation.
Product Properties

Our spun piles and poles are manufactured centrifugally and steam cured at controlled pressure and temperature. Compared to traditional piles, the lower weight and higher strength of our piles make them more cost effective to transport and reduce the time of handling and installation. Embedded angles in spun piles can be welded easily to join pile sections making installation of multiple sections more efficient and less time consuming. The strong bond between the pre-tensioned steel elements and the concrete counteracts the tendency for pile head breaking during installation. Cutting, if needed, is possible at any height. Connecting the pile head to the foundation is done according to the international standards and instructions by the embedded reinforced bars resulting in easy and rapid execution, lower expenditure and stronger protection of the pile structure during pile connection to foundation.

Pile structural load calculation

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<tr>
<th>Properties of BGA HPC Pile - Standard Products</th>
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<td>Nominal Diameter</td>
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3.3 ACTIONS AND COMBINATIONS FOR STRENGTH AND SERVICEABILITY DESIGN

3.3.1 Actions and loads

3.3.1.1 General

The design of a pile for ultimate strength and serviceability limit states shall take account of appropriate action effects arising from the following:

(a) All actions specified in AS/NZS 1170.0 and other relevant actions.

(b) Permanent actions of pile and pile cap.

(c) Ground movement, including negative friction, expansive soils, and vertical and lateral earth movements that may arise from various sources.

(d) Handling.

(e) Installation.

(f) Any other additional loads and actions that may be applied, e.g., impact, dynamic loading, water pressures and scour.

Bonyan Gostar Arvand Co.
Raw Materials

Aggregates  BS 882:1992 Standard, 10 - 20 mm diameter, river clean or washed gravel, SE > 80
Cement  MS 522:1989 or ASTM C150-72 Standard, Ordinary Portland Cement (OPC)
Pre-tensioned Steel  High strength steel in accordance with JIS G 3137:1994 Standard or the equivalent
Stirrup or PC Steel Bar  Steel Bar in accordance with BS4482 or ASTM A82-97 Standard
End Plate Flange  Ordinary steel in accordance with BS4482 or ASTM A82-97 Standard

Mechanics of Materials

Our piles’ high density concrete with high strength grades maintains concrete durability and stability during its service. This concrete has a 28-day compressive strength of 74 MPa and chloride penetration resistance of 0.01 classifying it as Excellent according to ASTM C1202. In addition, showing wave speed of 4.5 km/s in ultrasonic tests for different samples puts quality of this concrete in Excellent class in accordance with ASTM C597.
### 3.3.1.2 Ground movement
Allowance shall be made for actions induced by ground movements, as follows:

(a) Where a pile is situated in ground undergoing settlement, allowance shall be made for actions (F_{nt}) due to negative friction acting on the pile.

(b) Where a pile is situated in swelling soils, such as reactive clays or those subjected to frost action, allowance shall be made for the compressive and tensile actions (F_{est}) that may be developed in the pile.

(c) Where a pile is subjected to lateral ground movements, allowance shall be made for bending moments, shear forces and axial actions (F_{erm}) induced by such movements.

(d) Where a pile is subjected to heave due to unloading of the ground via excavation, allowance shall be made for bending moments, shear forces and axial actions (F_{eh}) induced by such movements.

NOTE: When using raking piles, vertical ground movements may also cause bending moments and/or shear forces in the pile together with axial actions.

(e) Where displacement piles are installed at relatively close spacings, consideration shall be given to vertical and lateral displacements, compression and tensile actions, and bending moments induced in piles that have already been installed.
Pile Installation Procedure

Ease of driving and installation at project site is a key benefit of using PHC piles. Moreover, if two or more piles are to be connected, they can easily be welded by head and toe embedded flanges.

CAP Connection

Thanks to the strong bond between the steel used in our piles and the concrete, cutting the pile head is possible at any point on the length of the pile. When connecting to the foundation, PHC piles do not need head breaking and can be easily connected to CAP rebars as illustrated. This reduces installation costs, expedites and facilitates execution and protects the pile structure from possible damage.
Building on our goal to provide leading-edge soil improvement services, BGA's hydraulic static pile drivers can expedite and facilitate the execution of your soil improvement projects efficiently and quietly.

Our equipment can:
- rapidly install our piles (up to 8.5 meters per minute)
- operate without vibration-free and make piling possible in close proximity of existing structures
- install piles vertically at high accuracy and with angles of up to 20-degree batter piling
- operate with a high level of safety
- operate autonomously without a requirement for an additional crane
- easily connect two piles during installation

SECTION 3 DESIGN REQUIREMENTS AND PROCEDURES

3.3.1.3 Handling
Stresses induced in a pile by handling during manufacture, transport and on site, as appropriate, shall be determined by taking account of the number and location of lifting points, the mass of the pile and the length of the pile. The minimum load factor for handling shall be 1.5.

3.3.1.4 Installation
For driven piles, allowance shall be made for the stresses induced during installation.
NOTE: The negative friction action should be determined with due conservatism, particularly where possible set up and/or time-dependent strain softening are not accounted for explicitly.

SECTION 6 DURABILITY DESIGN

6.1 GENERAL
This Section sets out requirements for plain, reinforced and prestressed concrete and steel piles with a design life of 50 and 100 years, and timber piles having a design life.

6.2 GENERAL PRINCIPLES OF DURABILITY DESIGN
The durability of piles shall be determined taking into account the aggressivity of the ground and the environmental conditions. Appropriate measures shall be taken to achieve the design life. The piles shall be designed to remain in a safe and serviceable condition to the end of their design life.
HSE, Strategy and Objectives

BGA has set directions for effective Health, Safety and Environment management including:

- Commitment to continuous improvement of HSE Management System
- Commitment to always comply with the spirit and the word of codes, laws and values
- Commitment to reducing accident risks and improving workplace and workforce health, safety and environment

Eco-friendly actions and commitment to reducing major risks of health, safety and environment includes:

- Waste management and minimum energy consumption
- Reducing wastes
- Benchmarking our performance against pioneering green initiatives
- Environmentally-based actions toward Sustainable Development Goals
- Reducing the major environmental risks of new development plans, products and services

SECTION 6 DURABILITY DESIGN

6.3 ACID SULFATE SOILS

In certain areas, particularly in coastal marine deposit areas, the presence of considerable amounts of iron sulfides is possible. Disturbing or exposing these soils to air or changing groundwater level conditions may cause the formation of sulfuric acid.

6.4 DESIGN FOR DURABILITY OF CONCRETE PILES

6.4.1 General

Durability shall be allowed for in the design of concrete piles by assessing the exposure classification for a pile in accordance with Clause 6.4.2, and for that exposure classification complying with the requirements for—

(a) minimum concrete strength and reinforcement cover in Clause 6.4.3(a);

(b) restrictions on content of certain chemicals in Clause 6.4.3(b);

(c) cover for concrete placement in Clause 6.4.3(c);

(d) limitation on crack width in Clause 6.4.3(d); and

(e) selection of concrete aggregates in Clause 6.4.3(e).
4.5.3.1 Reinforcement for precast concrete piles—Pile beam-column behavior is determined, to a great extent, by the reinforcement ratio. A lightly reinforced section, with approximately 0.5 percent steel, will have approximately the same cracking and yield moments, implying an extremely large reduction in stiffness after cracking leading to imminent collapse. At 1.0 percent steel, the yield moment would be more than twice the cracking moment, but the decrease in stiffness after cracking is still important.

At 1.5 percent longitudinal steel content, the yield moment will be 3.5 to 4 times the cracking moment and the loss of stiffness at cracking is less important. Piles with less than 1.5 percent steel have been used successfully in some soil conditions, but great care is required in handling, transportation, and driving to avoid damage due to excessive bending stresses.

The loss of stiffness at cracking can be extremely important for a pile in which column length effects become important, such as in piles extending through air or water. Because of this behavior, the committee recommends reinforced concrete piles that are driven to their required bearing values have a longitudinal steel cross-sectional area not less than 1.5 percent nor more than 8 percent of the gross cross-sectional area of the pile. If after a thorough analysis of the handling, driving, and service-load conditions, the designer elects to use less than 1.5 percent (of gross area) longitudinal steel, such use should be limited to nonseismic areas.

At least six longitudinal bars should be used for round or octagonal piles, and at least four bars for square piles. Longitudinal steel should be enclosed with spiral reinforcement or equivalent hoops. Lateral steel should not be smaller than W3.5 or D4 wire (ASTM A1064/A10M-10) and spaced not more than 6 in. (150 mm) on centers. The spacing should be closer at each end of the pile.
Engineering & Designing Services

BGA’s engineers, in cooperation with our sister company APG (www.ariaoil.com) are ready to deliver services to all industries.

Our experienced engineering team reviews each project to ensure that the clients’ specific needs are met.

Twenty years of engineering experience in soil studies and geotechnical design and execution plans, developing technical infrastructures and quality control inspection can provide tailor-made services for every project and client.

Our services include environmental and workplace studies, detail engineering as well as testing, inspection and supervision.

Our services are in complete accordance with national and international standards and can meet the engineering needs in all industries.

SECTION 6 DURABILITY DESIGN

6.4.3 Durability requirements

Durability of concrete piles shall be promoted by adherence to the following requirements:

(a) Protective measures

Protective measures shall be chosen—
(i) by adoption of the minimum requirements of Table 6.4.3 in regard to concrete strength and cover for reinforcing steel and tendons depending on the design life required; or
(ii) by a design life assessment of concrete durability, utilizing proven numerical procedures.

(b) Restrictions on chemical content in concrete piles

(c) Minimum cover to reinforcement for concrete placement. For concrete placement the following shall apply:

(i) The cover and arrangement of steel shall be such that concrete can be properly placed and compacted.

(ii) The cover shall be not less than the maximum of 1.5 times the nominal aggregate size and the cover given in Table 6.4.3.

(iii) For severe and very severe exposure classifications, consideration shall be given to using an inert liner and/or coating in addition to the specified concrete cover.

(d) Crack width

Crack width shall not exceed 0.3 mm.

(e) Concrete aggregates

Concrete aggregates shall comply with AS 2758.1 with exposure classifications as detailed in AS 3600.
A Summary of Section 6 of Australian Standard AS2159-2009: Durability Design (summarized for Driving Concrete Piles)

6.1 General
This section sets out requirements for plain, reinforced and prestressed concrete and steel piles with the design life of 50 to 100 years, and timber piles having a design life as detailed in Clause 6.6. For other pile materials, the general principles of durability design set out in this section shall be followed.

6.2 General Principles of Durability Design
The durability of piles shall be determined taking into account the aggressivity of the ground and the environmental conditions. Appropriate measures shall be taken to achieve the design life (whether in or out of the ground in contact with soil, water or air). The piles shall be designed to remain in a safe and serviceable condition to the end of their design life.

6.3 Durability Requirements
A) The cover for concrete piles for corrosive and highly corrosive environments for a 50 year design life shall be not less than the maximum of 1.5 times the nominal aggregate size and 40 mm given in the table 6.4.3. In addition, minimum concrete strength shall be not less than 50 MPa.
B) Design life assessment of concrete durability, utilizing proven numerical procedures supplemented by laboratory assessment under conditions that imitate the design life conditions (e.g. chloride diffusion testing)
C) Crack Width shall not exceed 0.3 mm.
D) Restrictions on chemical content shall be as given in AS3600 for a 50 year design life.
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