

Approval & Reception Procedure

DG – Geotechnical Department	
610 bored pile and socketed H pile	Document no.: ARP/DG/26
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1. Reference standard and regulation

《Regulamento de Fundações》, 《Guia de Dimensionamento de Fundações》, 《Norma de Betões》, 《Norma de Cimetros》、《Regulamento de Estruturas de Betão Armado e Pré-Esforçado》, ARP/DG/11, ARP/DG/13, ARP/DG/14, ARP/DG/16, ARP/DG/18, ARP/DG/19, ARP/DG/20, 《Code of Practice for Foundations 2017 香港 Buildings Department, HK》、《Technical code for testing of building foundation piles, JGJ 106-2014》、《Technical specification for Testing of boreholes of cast-in-place piles and diaphragm walls, DB32/T 4115-2021》、《Technical specification for testing of borehole of cast-in-place piles, T/CECS 596-2019》。

2. Scope of application

- 2.1 This procedure is only applicable to bored piles (hereinafter referred to as “610 piles”) and rock-socketed H-piles (Socketed H-Pile) commonly used in Macau, with a diameter of approximately 610mm, which are mainly drilled using steel casing, rotary drilling, pneumatic hammering (such as the ODEX system), or other drilling methods. °
- 2.2 “610 piles” generally refer to bored piles, with pile diameter is approximately 610mm, in which a steel cage is placed after the hole is drilled and concreting (or non-shrinkage cement). If the pile is designed with rock-socketed, the pile diameter is approximately 530mm or larger but not more than 610mm within the rock-socketed section.
- 2.3 “Socketed H-pile” generally refer to bored piles, with pile diameter is approximately 610mm, in which a steel H pile is placed after the hole is drilled and concreting (or non-shrinkage cement). The pile diameter is approximately 530mm or larger but not more than 610mm within the rock-socketed section.

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2.4 For the bored piles with diameter is larger than 610mm , the approval & reception procedure ARP/DG/18(Bored piles) should be complied °

2.5 For bored piles with a diameter between 450 and 610 mm, their applicability to this procedure should be assessed based on the project's technical specifications and contract documents. Mini piles with a diameter of 450 mm or less are not applicable for this procedure.

3. Information submission

3.1 Geological information (Site investigation)

3.2 Conditions of construction site (i.e. : size, range, terrain, slopes, access, constrain etc.)

3.3 The location and condition of existing buildings or adjacent structures (e.g. buildings, roads, utilities and services), underground structures and foundations

3.4 Engineering design and technical specifications

3.5 Construction proposal

3.6 The documents should be submitted including but not limited product catalog, quality system approval certificate, production certificate, performance test report etc. for the materials of steel cage, steel bar, steel coupler, U-shape buckle, pile toe pads, H piles, steel shear nail/strip, steel stiffness plate, concrete, cement grout, addition agent of concrete or cement, welding rod etc.

3.6 In addition to the above information, all the information specified in clause 4.1 of EN 1536:1999 may be required to be submitted. The submitted information shall include the soil investigation report, the requirements of Articles 42 and 43 of the 《Regulamento de Fundações》 and the additional information required as specified in clause 5.2 of EN 1536:1999.

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4. Reception procedure

4.1 Reception tests for welded joint

Permanent steel casing, H pile, steel shear nail/strip, steel stiffness plate : as the main structure of pile, reception test for welded joint should comply with 《Quality Control of Steel Structure Engineering, ARP/DEE/005》、《Welded Joint of Steel H Pile and Steel Pipe Pile, ARP/DG/16》 and the requirements of engineering design and the technical specification, and the reception procedure should be conducted according to stricter acceptance criteria :

- ◆ For the joints with full penetration butt welds , 100% nondestructive testing shall be performed.
- ◆ For the joints with fillet welds and partial penetration butt welds, 100% visual inspection of all welds as well as no less than 10% non-destructive testing shall be performed.

4.2 Reception tests for concrete / cement grout

For the reception tests of concrete or cement grout used in the casting of 610 piles and socketed H-piles, including but not limited to trial mix verification, slump tests, consistency tests, temperature tests, compressive strength tests, impermeability performance, chloride ion content, resistance to chloride ion penetration, expansion rate, bleeding rate, and other performance indicators, the reception procedures shall comply with the 《Ready Mixed Concrete ARP/DMC/014》 and the requirements of the engineering design and technical specifications , and which should be conducted according to stricter acceptance criteria.

4.3 Reception tests for steel bar, coupler, H pile, permanent steel casing

The material performance reception tests such as geometric characteristics, chemical properties, mechanical properties, evidence of production control execution, and other characteristics, for the steel bar and coupler used for 610 pile, and for H pile used for socketed H pile, and for permanent steel casing for

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either, shall comply with 《Steel Reinforcement Bars ARP/DMC/015》、《Mechanical Coupler for Steel Reinforcement Bars ARP/DMC/018》、《Quality Control of Steel Structure Engineering, ARP/DEE/005》、《Welded Joint of Steel H Pile and Steel Pipe Pile, ARP/DG/16》, and which should be conducted according to stricter acceptance criteria.

4.4 Reception tests for drilling fluid or bentonite

When drilling fluid or bentonite is used for wall protection during the drilling of foundation piles, it shall comply with the requirements for density, Marsh funnel viscosity, fluid loss, pH value, and sand content as specified in 《Bored Piles, ARP/DG/18》 as shown in Table 1 :

Table 1 – Properties of drilling fluid or bentonite

Test item	Unit	Drilling fluid or bentonite		
		New	Recycle	Before concreting
Density	g/cm ³	< 1.10	--	< 1.15
Marsh value	sec	32 – 50	32 – 60	32 – 50
Fluid loss	cm ³	< 30	< 50	--
pH value	--	7 – 11	7 – 12	--
Sand content	% (mass)	--	--	< 4

4.5 Reception tests for foundation piles

Test categories and frequencies for “610 piles” (including rock-socketed piles and non-rock-socketed piles) and “socketed H-piles” are detailed in Table 2 and Table 3.

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Table 2 – Reception tests for foundation piles

Test / inspection item	Frequency	Reception criteria	Remark
Verticality ultrasonic test (KODEN)	No less than 20% of total piles amount and at least 1 test for each pile cape	Engineering design and technical specification ; RF Artº 99 ;	(a)
Integrity test (SIT)	When necessary ; LECM suggestion	ARP/DG/09	(b)
Cross hole sonic logging test (CSL Test)	100% of total piles amount	ARP/DG/11	(c)
Static compressive test (SLT – CT)	1% of total piles amount and at least 1 test	ARP/DG/13	(d)
Static tensile test (SLT – TT)	When necessary ; LECM suggestion	ARP/DG/13	
Static lateral test (SLT – LT)	When necessary ; LECM suggestion	Engineering design and technical specification	
Dynamic loading test with signal matching (DLT-SM)	When necessary ; LECM suggestion	ARP/DG/14	
Proof core test (interface core/ socketed length / full core)	See Table 3	Engineering design and technical specification	

Remark :

- For the drilled hole of trial pile, 100% of total trial pile amount should be performed. For the foundation pattern of “1 column 1 pile”, 100% of total pile amount should be performed.
- This item is not applicable for “socketed H pile”.
- At least 1 core tube with diameter no less than 100mm and 1 access tube with diameter no less than 50mm should be reserved in steel reinforcement cage. This item is not applicable for “socketed H pile”.
- When static compressive test (SLT-CT) cannot be performed with suitable condition, 2 piles should be performed dynamic loading tests with signal matching (DLT-SM) as a substitution for one static compressive test (SLT-CT).

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Table 3 – Test frequency of proof core test

Inspection item / pile	“610 piles” (including rock-socketed piles and non-rock-socketed piles)		“socketed H-piles”
	CSL test performed and core tubes are reserved	No CSL test performed or no core tubes are reserved	
Full core	Not applicable	5% of total pile amount and at least 1 test, or LECM suggestion (*)	Not applicable
Socketed length core	Not applicable		10% of total pile amount and at least 1
Interface core	10% of total pile amount and at least 1 test, or LECM suggestion		test, or LECM suggestion (**)

備註：

(*)：Without damaging the steel reinforcement cage, full core drilling of the pile should be carried out from the pile top to a depth of at least 1 meter below the actual pile bottom into the bearing layer. Through a single full core drilling operation, the whole pile body, the rock-socketed section, the interface with the bearing layer, and the quality of the bearing layer rock can be inspected simultaneously. Core samples should be collected for compressive strength test.

(**)：1 access tube with a diameter not less than 100mm should be reserved. Drilling operation should be carried out continuously from the actual rock surface that comply with the design requirement, to a depth of not less than 1 meter into the bearing layer. Through a single drilling operation, the rock-socketed section, the interface with the bearing layer, and the quality of the bearing layer rock can be inspected simultaneously. Core samples should be collected for compressive strength test.