

Approval & Reception Procedure

DMC – Departamento de Materiais de Construção	
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1 Reference standard

The Reference standards are GB 13476-99, JIS A5337-95, BS1881: Part 120-1983, JC/T947-2005.

2 Approval procedures

2.1 Definitions

- PHC Pile sections : Cylindrical prestressed hollow pile elemental component, of precast high strength concrete, using spinning process, with a specified concrete strength of 80 MPa, and including end steel plates, to enable weld connections between elements.
- Pile section type : Classification of pile sections according to the specified limit value of cracking moment for bending.
- Pile section model : Pile sections of the same type, with the same diameter and thickness, regardless of their length.
- Lot : Quantity of pile sections, of the same model, delivered to site and submitted for reception.

2.2 Approval of the manufacturer

2.2.1 Manufacturers certified by LECM

Manufacturers with the factory Production Control System certified by LECM are considered approved for supply of pile sections to Macau. The LECM's web site gives permanent information on current status of all certified manufactures.

2.2.2 Manufacturers not certified by LECM

Manufacturers wishing to supply to Macau the pile section models to be used in a project, must follow the procedure for approval presented below.

2.2.2.1 The following information concerning the pile section models shall be submitted for verification.

- a) Pile section catalogue of the proposed factory.

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b) Information regarding the factory Production Control System, namely about the following items:

- quality manual and the related quality documentation;
- technical information about the sources of raw materials and the related recent test results;
- product test results and testing plans;
- testing laboratory facilities, relevant test procedures, as well as calibration of all testing equipment.

c) Statistical summary of:

- concrete compressive strength test results and
 - prestressing strands tensile strength test results,
- for the last six months, including, at least, the testing frequency and the average, standard deviation, maximum and minimum values of the test results. Conformity with the product standard requirements shall be demonstrated.

d) Pile section bending strength test results (including cracking moment and ultimate moment) for each pile section model to be used in the project, not older than six months, performed by a recognized testing laboratory. Results of tests performed at the factory, under the supervision of a recognized institute, may also be accepted if accompanied by:

- test procedure;
- list of testing equipment used and copy of the calibration certificates;
- test report prepared by the institute responsible for test execution or supervision;
- qualification of the institute responsible for test execution or supervision.

e) Test results of:

- alkali content of cement and
- potential reactivity of aggregates with cement alkalis,

not older than six months, as supplementary information for assessment of the quality of the raw material used in the PHC pile section. These tests shall be performed by a recognized testing laboratory and their results shall comply with the Macau Standard for Concrete.

2.2.2.2 After submission of the documentation, a visit of LECM to the factory must be arranged, in order to verify the implementation of the factory Production Control System. In case the

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factory was approved, in accordance with this procedure, for supplying pile sections to Macau during the previous 6 months, and no relevant modification in the factory Production Control System was introduced, this visit may not be necessary.

3 Reception procedure

After approval of the manufacturer, reception tests must be carried out in the pile sections to be used in the project.

3.1 Reception test

3.1.1 Reception tests are of three different kinds, as described below.

- Cracking moment test: following the Chinese standard GB 13476-99 or the Japanese standard JIS A5337-95, performed on one sample of two pile sections.
- Concrete compressive strength test and verification of spiral wire diameter: following the British Standard BS 1881: Part 120-1983, performed on 3 sets of 2 cores (total 6 number) for each sample pile section, taken normal to the length of the pile section from 3 transverse sections; the core diameter is 70 mm for pile section thickness lower than 125 mm and 100 mm for pile section thickness higher than or equal to 125 mm.

After the completion of concrete compressive strength test, one of the six cores will be broken in order to obtain the spiral wire for further verification of diameter.

- Dimensional and visual inspection:

Item	Followed Standard / Specification
Dimension and appearance of PHC pile sections	Chinese Standard GB13476-99 or Japanese standard JIS A5337-95
Appearance of steel joint plate	Chinese Standard JC/T947-2005
Dimension and appearance of pile shoes	PHC pile section manufacturer's specification

3.1.2 For the manufacturer not certified by LECM, cracking moment tests shall be performed, as reception tests, by an independent, recognized testing laboratory or at the factory under the supervision of a recognized institute, in the same conditions as referred in 2.2.2.1 d). The

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testing frequency is indicated in Table A and depends on the pile section type, as defined in the Chinese and in the Japanese standards mentioned above.

For projects where the quantity of each pile section model does not reach the values stated in Table A, the cracking moment tests are not required. For the projects where tests are required, the sample shall be tested before the delivery of corresponding quantity stated in Table A, with the witness of LECM.

Table A – Test frequency of cracking moment tests
for manufacturer not certified by LECM

Pile section type	Test frequency
A	1 sample of 2 pile sections shall be tested every 30,000 m, for projects with more than 30,000 m of each pile section model
AB (1)	1 sample of 2 pile sections shall be tested every 20,000 m, for projects with more than 20,000 m of each pile section model
B and C	1 sample of 2 pile sections shall be tested every 10,000 m, for projects with more than 10,000 m of each pile section model

⁽¹⁾ –only for the Chinese standard GB13476-99

3.1.3 All pile sections delivered to site shall be accompanied by a delivery list issued by the factory indicating the pile section model, the pile section identification, the casting date and the visual inspection record.

3.1.4 The pile sections delivered on site shall be divided into reception lots for concrete compressive strength tests, verification of spiral wire diameter, and dimensional and visual inspection. The composition of each reception lot, including also the quantity of pile shoes, shall be submitted before the performance of reception test. For the pile shoes not fabricated by the manufacturer

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of pile sections, mill certificate of parent material shall be submitted together. All tests must be performed by an independent, recognized testing laboratory.

The lot size and the sampling frequency are presented in Table B for manufacturers that are not certified by LECM and in Table C for manufacturers that are certified by LECM.

Table B – Lot size and sampling frequency
for manufacturers not certified by LECM

Total length of each pile section model used in the project (m)	Lot size	Concrete compressive strength test	Dimensional and visual inspection
< 500	All pile sections	-	10 pile sections and 10% of pile shoes with a minimum of 1 pile shoes
≥ 500 and < 20,000	≤ 200 pile sections	1.5% of the pile sections	10% of the pile sections and pile shoes with a minimum of 10 pile sections and 1 pile shoes
≥ 20,000	≤ 200 pile sections	1.5% of the pile sections for the first 20,000 m and 0.5% for the remaining	10% of the pile sections and pile shoes with a minimum of 10 pile sections and 1 pile shoes

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Table C – Lot size and sampling frequency
for manufacturers certified by LECM

Total length of each pile section model used in the project (m)	Lot size	Concrete compressive strength test	Dimensional and visual inspection
< 500	All pile sections	-	10 pile sections and 10% of pile shoes with a minimum of 1 pile shoes
≥ 500	≤ 200 pile sections	0.5% of the pile sections	10% of the pile sections and pile shoes with a minimum of 10 pile sections and 1 pile shoes

3.1.5 Pile sections or Pile shoes belonging to each lot cannot be used before acceptance of the reception tests

4 Acceptance criteria

4.1 As regards the pile section cracking moment reception test and only for manufacturer not certified by LECM, from the production of each pile section model to be delivered to a particular project, samples of two pile sections will be chosen for testing, according to the frequency defined in Table A. Any tested pile sections shall display no sign of cracking when the specified cracking moment is reached. In case both pile sections fail to meet the test requirement, the whole production of this pile section model shall be rejected. In case one of the pile sections fails to meet the test requirement, four additional pile sections from the same production and model will be tested. If any one of these four pile sections fails, the whole production of this pile section model shall be rejected.

4.2 As regards the concrete compressive strength and the diameter of spiral wires, all conditions below shall be verified for each lot:

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- The average value of six estimated in-situ cube strength results (calculated as indicated in 4.4) should not be less than the specified strength (80 MPa);
- The estimated in-situ cube strength result of any individual core (calculated as indicated in 4.4) should not be less than 85% of the specified strength (68 MPa);
- For pile sections which outer diameter ≤ 450 mm, the diameter of spiral wires shall not be less than 4 mm;
For pile sections which outer diameter 500 mm ~ 600 mm, the diameter of spiral wires shall not be less than 5 mm;
For pile sections which outer diameter 800 mm ~ 1000 mm, the diameter of spiral wires shall not be less than 6 mm;

In case of failure to meet all above requirements, all the pile sections of the same model and casting date will be deemed to be unacceptable for the project and shall be rejected. Two additional pile sections from the same lot, but from different casting dates, shall be used for further verification. If any one of these two tests fails to comply with all above requirements, all the pile sections of the lot shall be rejected and all the pile sections of the same model and casting date will be deemed to be unacceptable for the project and shall be rejected.

After non-compliance of two consecutive lots with the above requirements, all pile sections of the same model will be deemed to be unacceptable for the project and shall be rejected.

4.3 As regards dimensional and visual inspection, all inspected pile sections must meet the following criteria. Each pile section that fails to comply with this requirement must be rejected. Two additional pile sections shall be inspected for each non-conforming pile section.

Item	Followed Standard / Specification
Dimension and appearance of PHC pile sections	Chinese Standard GB13476-99 or Japanese standard JIS A5337-95
Appearance of steel joint plate	Chinese Standard JC/T947-2005
Dimension and appearance of pile shoes	PHC pile section manufacturer's specification

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4.4 The compressive strength of the cores shall be adjusted for length / diameter ratio and direction of drilling ($D = 2.3$, to be considered as equivalent to cores drilled vertically) and converted to estimated in-situ cube strength in accordance with 7.2 of BS1881: Part 120: 1983 and AMD 6109: 1989.

4.4.1 Estimated in-situ cube strength

4.4.1.1 For cores free of reinforcement: Calculate the estimated in-situ cube strength to the nearest 0.5 N/mm² from the equation

$$\text{Estimated in-situ cube strength} = \frac{D}{1.5 + \frac{1}{\lambda}} \times \text{Measured compressive strength of core}$$

where

D is 2.5 for cores drilled horizontally (for precast units perpendicular to height when cast); or 2.3 for cores drilled vertically (for precast units parallel to height when cast);

λ is the length (after end preparation) / diameter ratio.

NOTE: It should be noted that in-situ strengths estimated from the above formula cannot be equated to standard cube strengths.

4.4.1.2 For cores with reinforcement perpendicular to the core axes: Calculate the estimated in-situ cube strength by multiplying the strength obtained from the formula in 4.4.1.1 by the following factors:

- for cores containing a single bar:

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$$1.0 + 1.5 \frac{\phi_r \cdot d}{\phi_c \cdot \ell}$$

- for specimens containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of $\phi_r \cdot d$ need be considered. If the bars are further apart, their combined effect should be assessed by using the factor:

$$1.0 + 1.5 \frac{\sum \phi_r \cdot d}{\phi_c \cdot \ell}$$

where

ϕ_r is the diameter of the reinforcement;

ϕ_c is the diameter of specimen;

d is the distance of axis of bar from nearer end of specimen;

ℓ is the length of the specimen after end preparation by grinding or capping.