Pile Foundations

To facilitate the processing of pile foundation submissions and to ensure proper design and construction of pile foundation works, the following guidelines should be observed.

Recognized Types of Pile Foundation

2. A recognized type of pile foundation is regarded as the piling system recognized by the Building Authority (BA) prior to the approval of piling plans through the submission of relevant technical details for assessment, normally by the registered structural engineer (RSE) in conjunction with the registered specialist contractor (RSC) experienced in such system. A list of recognized types of pile foundation is available on the Buildings Department (BD) website (www.bd.gov.hk/english/inform/CDB/CDBRPT.pdf).

3. Where it is proposed to use a piling system, which is not a recognized type, the RSE is advised to prove its acceptability to the BA before detailed piling plans are submitted for approval. To enable the BA to fully consider the system, all relevant technical details of the materials, manufacturing process, structural design, method of installation and assessment of its effects on adjacent and nearby buildings, structures, land, streets and services, method of assessing foundation capacity and applicability relating to ground conditions and selected examples of the use of the system elsewhere, if applicable, should be submitted following which a demonstration of the system may be called for.

Piling Plans Submission

4. The following particulars are required, under Building (Administration) Regulations 8 and 10, to be included in the pile foundation submission for approval:

Particulars to be shown on the piling plan

(a) a block plan showing the location of the site;

(b) details showing the characteristic features of the site and environments, including locations of ground investigation boreholes, slopes, existing foundations, nullahs, retaining walls and the like;

(c) layout arrangement, identification, expected depths and cut-off levels of the piles;

(d) layout arrangement of the pile caps;

/(e) .....

(e) size, shape and structural details of the pile element, including details of the shoe, head, splices and cap/pile connection;

(f) pile bearing capacity and method of verification thereof on site;

(g) specification of structural materials;

(h) magnitude of characteristic dead, imposed and wind loads and their critical combinations acting on each pile or each group of piles;

(i) installation specifications including the founding criteria, method of installation, maximum number of piles to be installed concurrently, construction plants details, method of overcoming underground obstruction etc;

(j) method of controlling and monitoring the verticality, inclination and alignment of the piles during installation;

(k) details of monitoring requirements for the adjacent and nearby buildings, structures, land, streets and services arising from the proposed piling works. The requirements should include a system of three triggering levels, namely the alert, alarm and action levels respectively and the corresponding contingency measures for each level to be carried out by the RSE and the RSC. The following example giving the succinct requirements may be used as reference:-

Level	Contingency Measures
Alert	More frequent monitoring measurements to be conducted and/or additional check points to be installed.
Alarm	The method of installation of the pile foundation has to be reviewed with the purpose of mitigating the detrimental effects arising from vibration or ground settlement
Action	The corresponding site works have to be suspended.

(l) Where dynamic pile driving formula is used, the parameters for the assessment of the ultimate pile capacity, such as the effective energy per blow, efficiency of blow and penetration of pile for a hammer blow.

Particulars to be given in separate documents

(m) site investigation report including results of ground investigation, necessary field and laboratory tests and photographs of all the soil samples and rock cores taken;

/(n) .....

(n) design calculations based on recognized foundation engineering principles; and

(o) appraisal report on the effects of the piling works on adjacent and nearby buildings; structures, land, streets and services, including any proposal of precautionary and protective measures.

5. The RSE's attention is drawn to Practice Note for Authorized Persons and Registered Structural Engineers and Registered Geotechnical Engineers (PNAP) APP-137 for Ground-borne Vibrations and Ground Settlements Arising from Pile Driving and Similar Operations in preparing the piling plan submission, in particular for items (k) and (o) in paragraph 4 above. In addition, the geotechnical reports and supporting documents if required should be prepared and signed by the registered geotechnical engineer.

Design of Pile Foundations

6. In the design of pile foundations, the general guidelines provided in the Code of Practice for Foundations should be followed.

Pre-design Ground Investigations

7. Prior to the design of the pile foundation, sufficient ground investigations should be carried out so that adequate information on the geology of the site can be obtained and hence the general founding levels of the piles can be estimated. For further guidelines on ground investigation works, please refer to PNAP APP-49.

Pre-drilling

8. For piles founded on rock, sufficient pre-drilling should be carried out prior to the installation works, such that the quality of the founding rock can be identified and the appropriate founding levels can be determined. The pre-drilling should be sunk to at least 5 m below the rock head of the specified grade.

9. Pre-drilling should be carried out for each of the large diameter bored piles, barrettes and the like, and the records of the pre-drilling should be submitted to BD at suitable intervals during the construction of the piles.

10. For minipiles, steel bearing piles driven to bedrock, socketed steel H-piles and similar small diameter bored piles founding on rock, pre-drilling at location in close proximity of the piles should be made. The number of pre-drilled boreholes required should be such that the pile tip of every such pile should be within 5 metres from a pre-drilled hole. The pre-drilling should be sunk into the rock mass for at least 5 m below the rock head of the specified grade or the designed length of the rock socket of the nearest pile, whichever is the deeper.

/Post .....

Post Construction Proof Drilling

11. When large diameter bored piles, barrettes and the like are completed, core-drilling should be carried out at the concrete/rock interface for each of these piles. To facilitate successful core-drilling at the interface, a pipe of not less than 150 mm diameter may be left in at about 1 m above the interface. The core-drilling should be carried down to at least 1 m below the interface.

12. It is always expected that the concrete should be in good contact with rock at the interface and the rock is consistently of the required grade beneath the pile base. However, minor imperfection observed during the interface core-drilling, such as a thin layer of sediment, segregated concrete or weathered seam in the rock beneath the pile base, may be considered acceptable provided that the RSE can demonstrate his acceptance with justifications. As an alternative, the RSE may include in the foundation plans, proposals of remedial works for rectifying any such imperfections at the interface if found. The proposals should provide details of the method statement and the supervision required by the RSE.

13. For minipiles, steel bearing piles driven to bedrock, socketed steel H-piles and small diameter bored piles founding on rock, there would be practical problem for core-drilling at the concrete/rock interface. To verify the rockhead profile and hence assess the adequacy of the socketed length for these types of piles, some additional proof drill holes should be sunk into the rock mass and down to at least 5 m below the as-built top level of the rock socket of the nearest pile or to the as-built bottom level of the rock socket of the nearest pile, whichever is the deeper. The number of post-installation boreholes should be at least 2 for sites with 100 piles or less; or 1% of the number of piles for sites with more than 100 piles (any fraction of a borehole so calculated should be construed as one additional borehole). The RSE should determine the location of the boreholes. When submitting the certificate on completion of the piling works (Form BA 14), the RSE should submit an assessment report with a rockhead contour plan based on the ground investigation, the pre-drilling and the post-installation drilling, together with the piling record plan.

Registered Specialist Contractor in the Ground Investigation Field Work Category

14. All ground investigation works, pre-drilling, interface core-drilling, post-installation drilling and proof test core-drilling must be carried out by a Registered Specialist Contractor in the Ground Investigation Field Works category. The contractor who is appointed to carry out proof test core-drilling required under Building (Construction) Regulation 30 should make declaration on its connection with the foundation contractor, including whether or not it is a holding/subsidiary/an associated company of the foundation contractor, or has financial relationship with it (e.g. cross-directorship), or has financial interest in the foundation works.

/Quality .....

Quality Supervision for Pile Foundations

15. Adequate supervision should be provided for the pre-drilling, construction and proof test of pile foundations to ensure built quality. Requirements for quality supervision to be provided for pile foundation works are stipulated in the Code of Practice for Site Supervision.

Ground-borne Vibrations and Ground Settlements Arising from Pile Driving and Similar Operations

16. Adequate control of ground-borne vibrations and ground settlements should be provided for the pile driving and similar operations. In this connection, requirements are stipulated in PNAP APP-137.

Pile Foundations in the Scheduled Areas

17. Some special requirements for pile foundations in the Scheduled Areas are given in PNAPs APP-24, APP-30, APP-61 and APP-62.

Form BA 14

18. Upon completion of the piling works, a specified Form BA14 certifying the completion should be submitted in the manner prescribed in Building (Administration) Regulation 25. For exceptionally large sites, foundation works may be suitably phased and separately considered for proof testing. BD should be consulted as early as possible on such special arrangement. To expedite the selection of piles for proof tests, piling record plans and reports may be separately submitted prior to the submission of the specified Form BA14.

Piling Record Plan and Reports

19. Upon completion of the piling work two sets of piling record plan and reports should be submitted as may be required under Building (Administration) Regulation 10 to certify the satisfactory completion of the piling works. These should include:

(a) a plan showing characteristic features of the site and the identification, location, depth and size of each pile as constructed;

(b) a report listing the date of construction, the quality and quantity of materials used and driving performance or excavation record of each pile;

(c) reports on any tests as required for the particular piling system; and

(d) an assessment report with rock head contour plans, as appropriate.

/Within .....

Within 14 days of the receipt of these documents, BD would inform the AP/RSE of the representative piles identified for proof tests. To avoid unnecessary delay, the AP/RSE should ensure that full information on the completed piles is included in the piling record plan and reports.

Proof Tests

20. Proof tests on foundation units are required under Building (Construction) Regulation 30. Except in special circumstances where the standard of acceptance is to be determined according to the design and factor of safety, the BA will normally be satisfied if the procedures and criteria described in the Code of Practice for Foundations are followed. Alternative procedures and acceptance criteria, supported by justification based on recognized foundation engineering principles and relevant to a particular site and building may also be adopted.

21. Alternative procedures and acceptance criteria, or methods other than test loading or core-drilling, which can demonstrate the performance of the foundation under loads or verify the integrity and the load-response interaction between the foundation unit and the bearing stratum may also be adopted. In this connection, the following should be submitted well in advance of the completion of the foundation works so that the BA may fully consider the suitability of the proposed method of testing:

(a) relevant recognized engineering principles and theories for the proposed method of testing;

(b) detailed procedures of testing;

(c) acceptance criteria;

(d) interpretation of the test results; and

(e) any verification tests performed to justify the parameters to be used in the proof test.

Further On Site Tests

22. Whenever doubt exists as to the design assumption or load carrying capacity of any pile foundation, further on site tests may be required under Building (Construction) Regulation 29.

Amendments to Approved Plans

23. For submission of amendment plans and their related consent applications, the fast track procedures for securing consent for amendments outlined in PNAP APP-97 shall apply.

24. Consent to the commencement of the pile cap and superstructure works will not be given until:

(a) satisfactory piling records have been submitted;

/(b) .....

(b) specified Form BA14 has been submitted;

(c) the required proof tests have been satisfactorily carried out; and

(d) all relevant imposed conditions including materials testing requirement have been complied with.

Concurrent Processing of Applications

25. Procedures are in place in BD for concurrent processing of applications for approval and consent in respect of new foundation works. Except in cases where any imposed condition should require to be first met, e.g. pre-construction condition survey to sensitive buildings, shoring to adjoining buildings to be completed before piling works may commence, BD will consider giving approval of plans for foundation works and consent for such works at the same time. If an AP or RSE wishes to take advantage of these procedures, he should co-operate with BD by ensuring that an application for consent is not submitted before the 32nd day of the submission of plans for approval, to avoid unnecessary complications in administrative work.

26. To minimize the idling time on construction sites, applications may also be made for consent to commence excavation works for substructures prior to the final completion of foundation works, provided that the supervision plan for the excavation works is submitted and any earth-retaining elements (such as sheet piles) have been satisfactorily installed. These procedures mean that earth-retaining elements may be installed concurrently with the foundation works, thereby allowing excavation works for substructures to be carried out while foundation record plans are being examined and proof tests arranged. Consent for the construction of substructure elements (pile caps, for example) will be given only after satisfactory completion of the required proof tests.

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