Building and Construction Authority

An MND Statutory Board

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Building Engineering Group (#12-00)
Tel : 1800 3425222
Fax : 6334 2561
Online feedback form:
https://www.bca.gov.sg/feedbackform/

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See **Distribution**

Dear Sir/Madam

REQUIREMENTS AND GUIDELINES ON THE USE OF DRIVEN OR JACKED PILES FOR BUILDING FOUNDATION

Objective

This circular is to inform the industry regarding the requirements and guidelines on the use of driven or jacked piles for building foundation. The design and construction of driven or jacked piles shall comply with Eurocode 7 and BS EN12699.

Background

2 There are issues related to the use of driven or jacked piles for foundation of buildings that need to be addressed in order to ensure that the installed piles are able to achieve its capacity. Observation from past projects have indicated that short piles and pile heave during piling work are issues that may be encountered during construction. If these issues are not detected and arrested early, the adequacy of the foundation could be undermined. Hence, design and construction of driven or jacked piles shall be performed in accordance with the requirements and guidelines stipulated in this circular, particularly for high-rise buildings underlain by thick layer of soft clay deposits. This is to ensure that the piles are installed properly before commencing the next phase of construction.

3 BCA has gathered feedback on this circular from the Institution of Engineers Singapore and Association of Consulting Engineers Singapore. To ensure that driven or jacked piles are installed properly, a differentiated approach based on the risk category of the buildings as tabulated in **Appendix A** is to be adopted. Depending on the classification of building, the requirements include the following: -

(i) additional information (listed in Table B1 of **Appendix B**) to be indicated on the piling plan submitted to BCA for approval;
(ii) heave monitoring of driven or jacked piles during installation; and
(iii) a written confirmation from the Commissioner of Building Control to be obtained, as described in **Appendix B,** before any structural works above the constructed pile (e.g., pile caps) can commence.

Design guidelines as listed in **Appendix C** in this circular are to assist Qualified Persons (the "QP") when carrying out the design of driven or jacked piles.

4 This circular is for compliance by QP, Accredited Checkers, site supervisors, builders / specialist builders and developers for projects adopting driven or jacked piles for building foundation. This will take effect for a project with the first structural plan submitted on or after the date of this circular.

5 This circular also serves to remind project parties to submit in a timely manner the following documents in the *Piling Advice Letter* which is issued by the Commissioner of Building Control together with the Notice of Approval for the first piling plan:

(i) Annex C form "Interim Certificate of Supervision on Piling Works" in *Piling Advice Letter* at 50% and 100% of pile installation for all piling works; and
(ii) Annex D form "Certificate of Monitoring Building Settlement" in *Piling Advice Letter* at the completion of erection of every multiple of 5 storeys until the final roof level.

6 Nothing contained in this circular is meant to replace or negate the need to comply with the provisions of the Building Control Act and Building Control Regulations in all aspects. QPs are to note that they have duties under the Building Control Act, amongst others, to take all reasonable steps and exercise due diligence to ensure that building works are designed and supervised in accordance with the provisions of the Building Control Act and Building Control Regulations.

7 We would appreciate if you could disseminate the contents of this circular to your members. Please contact us at Tel 1800-3425222 or through the online feedback form (https://www.bca.gov.sg/feedbackform/) should you need any clarification. Thank you.

Yours faithfully



ER. DR YET NAI SONG
DIRECTOR
FOUNDATION ENGINEERING DEPARTMENT
BUILDING AND CONSTRUCTION AUTHORITY
For COMMISSIONER OF BUILDING CONTROL

ASSOCIATIONS / SOCIETIES

PRESIDENT
INSTITUTION OF ENGINEERS, SINGAPORE (IES)
70, BUKIT TINGGI ROAD
SINGAPORE 289758

PRESIDENT
ASSOCIATION OF CONSULTING ENGINEERS, SINGAPORE (ACES)
18 SIN MING LANE
#06-01 MIDVIEW CITY
SINGAPORE 573960

PRESIDENT
SINGAPORE CONTRACTORS ASSOCIATION LIMITED (SCAL)
CONSTRUCTION HOUSE
1 BUKIT MERAH LANE 2
SINGAPORE 159760

PRESIDENT
SINGAPORE INSTITUTE OF ARCHITECTS (SIA)
79 NEIL ROAD
SINGAPORE 088904

PRESIDENT
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168 JALAN BUKIT MERAH CONNECTION ONE #10-01
SINGAPORE 150168
C/O SIPM CONSULTANTS PTE LTD

PRESIDENT
SINGAPORE INSTITUTE OF BUILDING LIMITED (SIBL)
9, AH HOOD ROAD,
#02-04,
SINGAPORE 329975

PRESIDENT
REAL ESTATE DEVELOPERS' ASSOCIATION OF SINGAPORE (REDAS)
190 CLEMENCEAU AVENUE
#07-01 SINGAPORE SHOPPING CENTRE
SINGAPORE 239924

PRESIDENT
SINGAPORE INSTITUTE OF SURVEYORS & VALUERS (SISV)
110 MIDDLE ROAD #09-00
CHIAT HONG BUILDING
SINGAPORE 188968

PRESIDENT
SINGAPORE STRUCTURAL STEEL SOCIETY (SSSS)
1 LIANG SEAH STREET
#02-11/12 LIANG SEAH PLACE
SINGAPORE 189022

PRESIDENT
GEOTECHNICAL SOCIETY OF SINGAPORE (GEOSS)
C/O GLOBEWERKS INTERNATIONAL PTE LTD
22 SIN MING LANE
#03-85 MIDVIEW CITY
SINGAPORE 573969

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PROFESSIONAL ENGINEERS BOARD, SINGAPORE (PEB)
52 JURONG GATEWAY ROAD, #07-03
SINGAPORE 608550

PRESIDENT
BOARD OF ARCHITECTS (BOA)
5 MAXWELL ROAD
1ST STOREY TOWER BLOCK
MND COMPLEX
SINGAPORE 069110

DIRECTOR OF INFRASTRUCTURE
INFRASTRUCTURE AND FACILITIES SERVICES DIVISION
SCHOOL CAMPUS DEPARTMENT
MINISTRY OF EDUCATION
285 GHIM MOH ROAD, BLOCK C, LEVEL 3
SINGAPORE 279622

DIRECTOR
PROCUREMENT & CONTRACTS DEPARTMENT
PUBLIC UTILITIES BOARD
40 SCOTTS ROAD #08-01
ENVIRONMENT BUILDING
SINGAPORE 228231

DEPUTY CHIEF EXECUTIVE
INFRASTRUCTURE & DEVELOPMENT
LAND TRANSPORT AUTHORITY
1 HAMPSHIRE ROAD
BLOCK 8 LEVEL 1
SINGAPORE 219428

DEPUTY DIRECTOR
PROJECT DEVT & MGT SECT 1 (C&S)
BUILDING QUALITY GROUP
HOUSING & DEVELOPMENT BOARD
HDB HUB
480 LORONG 6 TOA PAYOH
SINGAPORE 310480

AG DIRECTOR
TECHNICAL SERVICES DIVISION
JTC CORPORATION
THE JTC SUMMIT
8 JURONG TOWN HALL ROAD
SINGAPORE 609434

DIRECTOR
BUILDING
PEOPLE'S ASSOCIATION
9 STADIUM LINK
SINGAPORE 397750

PRESIDENT
THE TUNNELLING AND UNDERGROUND
CONSTRUCTION SOCIETY SINGAPORE (TUCSS)
C/O CMA INTERNATIONAL CONSULTANTS PTE LTD
1 LIANG SEAH STREET
#02-12 LIANG SEAH PLACE
SINGAPORE 189022

PRESIDENT
SOCIETY OF ROCK MECHANICS AND ENGINEERING GEOLOGY
1 LIANG SEAH STREET
#02-12 LIANG SEAH PLACE
SINGAPORE 189022

DEPUTY CHIEF EXECUTIVE OFFICER
SENTOSA DEVELOPMENT CORPORATION
33 ALLANBROOKE ROAD, SENTOSA
SINGAPORE 099981

HEAD (FIRE SAFETY AND BUILDING CONTROL)
BUILDING AND INFRASTRUCTURE
DEFENCE SCIENCE & TECHNOLOGY AGENCY
1 DEPOT ROAD
DEFENCE TECHNOLOGY TOWER A
SINGAPORE 109679
HOW AH MENG

DIRECTOR
BUILDING AND INFRASTRUCTURE
DEFENCE SCIENCE & TECHNOLOGY AGENCY
1 DEPOT ROAD
DEFENCE TECHNOLOGY TOWER A
SINGAPORE 109679

PRESIDENT
SINGAPORE GREEN BUILDING COUNCIL
BLOCK H, LEVEL 2
BCA BRADDELL CAMPUS
200 BRADDELL ROAD
SINGAPORE 579700

SPECIALISTS TRADE ALLIANCE OF SINGAPORE (STAS)
23 GENTING ROAD
#07-01 CHEVALIER HOUSE
SINGAPORE 349481

SINGAPORE INTERNATIONAL FACILITY MANAGEMENT ASSOCIATION (SIFMA)
BLK 201 KIM TIAN ROAD #03-400
SINGAPORE 160201

ASSOCIATION OF PROPERTY AND FACILITY MANAGERS (APFM)
110 MIDDLE ROAD
#09-00 CHIAT HONG BUILDING
SINGAPORE 188968

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Appendix A

Classification and Requirements of Buildings Proposed with Driven or Jacked Piles

	Type A Buildings	Type B Buildings	Type C Buildings
Classification of building	• All buildings that are 11 storeys or more (*excluding basement*) • Buildings that are 4 to 10 storeys and with soft clay[a] of thickness[b] exceeding 10m *(excluding all landed properties)*	• Buildings that are 4 to 10 storeys and with soft clay[a] of thickness[b] up to 10m *(excluding all landed properties)*	• All landed properties • All buildings up to 3 storeys • Buildings that are 4 to 10 storeys and without soft clay[a]
Pile-heave monitoring[c,d]	• 100% of working piles	• 50% of working piles	<u>For independent Type C Building</u> • Optional <u>For Type C Building that cannot be demarcated from Type A or/and Type B Building</u> • 50% of working piles
Written confirmation to allow the structural work above the constructed piles (e.g., pile caps) to commence	• Required	• Not required	• Not required
Submission of amendment for piles with a reduction of more than 20% of pile length (as per BCA's Circular 2009 – "Guideline on Submission of Amendment and Record Piling Plan")	• Required	• Required	• Required

Notes:

[a] *- Soft clay includes Marine Clay, Estuarine Clay and Fluvial Sand.*

[b] *- The thickness of soft clay that the pile will penetrate* ***during*** *pile installation (i.e., if piled from ground surface, thickness is to consider soft clay within the basement although it will eventually be excavated during basement construction).*

[c] *- Heave monitoring of steel H piles is not required unless QP assesses that the impact of heave induced by this type of pile is significant.*

[d] *- QP shall propose suitable means to enable pile-heave monitoring of piles with pile head below the ground level.*

Appendix B

Heave Monitoring of Pile Head

1.1 The requirements of heave monitoring of pile head are stipulated in **Table B-1** below: -

Table B-1: Requirements of Heave Monitoring of Pile Head

Stage	Requirements
Piling plan submission	QP to specify on plan the following details for pile-heave monitoring: - *(a) which of the installed piles will have their heave measured and monitored;* *(b) the allowable heave of each pile as Work Suspension Level (the "WSL"); and* *(c) the frequency of taking pile-heave measurement: -* *(i) immediately after the completion of the pile;* *(ii) at intermediate frequency proposed by the project party based on the ground condition, the likelihood of pile heave and the feasibility to manoeuvre the required equipment to rectify any pile heave; and* *(iii) at the completion of each phase/zone of piling works just before the next stage of casting (e.g., pile caps).*
	QP to specify on plan the rectification proposal when the pile heave exceeds the WSL.
Piling work	QP to submit the results of heave monitoring that have exceeded the WSL via the monthly submission of form Annex E "Monthly Instrumentation & Monitoring Results" to BCA.

Written Confirmation from Commissioner of Building Control for Commencement of Structural Works above the Constructed Piles (Applicable to Type A Buildings Only)

2.1 For Type A Buildings only, project parties shall obtain a written confirmation from the Commissioner of Building Control before any structural works above the constructed pile (e.g., pile caps) can commence, following the procedures in **Table B-2**. This written confirmation is not applicable to Type B Buildings and Type C Buildings. For Type B Buildings and Type C Buildings, structural works above the constructed pile can proceed once the QP has assessed that the piles have been installed as per the design requirements.

2.2 For Type A Buildings, to facilitate the sequence of onsite construction activities in phases, project parties may plan and submit the as-built piling record plans in several parts in accordance with the planning of the project. For each part of the as-built piling record plans that has been submitted and is in order, the QP may seek written confirmation from the Commissioner of Building Control to proceed with the structural works above the constructed piles for that part.

Table B-2: Procedures to Obtain the Written Confirmation

Stage	Procedures
Piling plan submission	QP to identify and determine the building type for all building blocks in the project in accordance with the classification criteria stipulated in **Table A-1**.
	For Type A Buildings, specify on piling plan submitted for approval that the written confirmation from the Commissioner of Building Control is required for these Buildings before any structural works above the constructed pile (e.g., pile caps) can commence.
Before commencing any structural works above the constructed pile for Type A Buildings	QP to submit to the Commissioner of Building Control the as-built piling record plan (either in part or in whole) for Type A Buildings.
	QP to email to the BCA processing officer (the "PO") to inform that the submitted as-built piling record plans for Type A Buildings have been endorsed with the following supporting documents: - *(i) status of submitted as-built piling records; and* *(ii) plans showing the submitted as-built piling records.* The Commissioner of Building Control will review the above submission, and where appropriate, issue a written confirmation to allow the structural work above the constructed piles to proceed.

Appendix C

Design Guidelines for Driven or Jacked Piles

1.1 The guidelines as presented in **Table C-1** should be considered when designing for driven or jacked piles.

Table C-1: Design Guidelines for Driven or Jacked Piles

Aspects	Design Guidelines
Design	Check the adequacy of boreholes for determination of soil stratification, and in compliance with requirements as stipulated below: - *(i) Joint BCA/IES/ACES/GEOSS circular "Requirements on Ground Investigation, Load Test and Quality Control Test for Foundations" issued on 22 Sep 2016; and* *(ii) "Guide on Ground Investigation and Geotechnical Characteristic Values to Eurocodes 7", issued by GEOSS in 2015.*
	Check that the proposed pile termination depth into competent ground stratum particularly hard soil with high values of SPT-N is penetrable by common piling equipment.
	Check that the proposed piles are not obstructed by boulders or intermediate hard soil layer.
	Consider the negative skin friction (NSF) of soft clay in pile geotechnical design.
	Design the pile termination criteria considering the following: - *(i) Loads that are not present during construction but may be generated due to long term consolidation of soil or ground water lowering (e.g., NSF);* *(ii) Temporary soil resistance during pile installation (e.g., positive skin friction from soft clay during installation which changes to negative skin friction in long term); and* *(iii) Shaft resistance above pile cut-off level.*
	Specify on plan the pile termination criteria: - *(i) Driven piles: weight of hammer, drop height, temporary compression, settlement / blow; and/or* *(ii) Jacked piles: jacked load, holding time, set movement.*
	Check that the total and differential design allowable settlements of the proposed building are within acceptable limits.
Impact assessment and protective measures	Assess the impact of installing the proposed driven or jacked piling works to all structures / buildings and their foundations within the piling influence zone and submit the impact assessment report.
	Specify adequate instrumentation on plan for monitoring the effect of pile installation to all structures / buildings and their foundations within the piling influence zone, including heave monitoring of pile head (refer to **Appendix B**).

Aspects	Design Guidelines
	Specify adequate protective measures (e.g., relief well around pile point, pre-boring at pile point, etc) on plan as recommended by "Good Practice for Installation of Jacked Foundation Piles in Singapore", issued by GEOSS in 2015.
	Specify load tests and/or integrity tests on plan for assessing the structural integrity of the installed piles upon completion of all the piles at site.
Rectification work	Specify rectification work on plan if the monitoring shows the constructed piles heave or move excessively.

Appendix D

Amendments to Conditions of Permit (For Information)

1.1 Project parties shall take note of the following amendments to the Conditions of Permit that are underlined and are applicable to projects involving the use of driven or jacked piles.

Piling

2. The Builder shall install adequate vibration monitoring devices before starting any piling works. In carrying out the piling works, the Builder shall implement precautionary measures to prevent excessive vibrations or damage to neighbouring properties.

2B. Where building works in the Project are carried out:

(i) for the construction of a proposed building that comprises 11 storeys or more (excluding basement) and adopts driven piles or jacked piles; or

(ii) for the construction of a proposed building that comprises 4 storeys to 10 storeys (excluding basement) and adopts driven piles or jacked piles which penetrate more than 10m of soft clay during installation,

the Builder and Supervising QP:

a) shall ensure that structural works (including pile caps) above the constructed piles do not commence until a written confirmation from the Commissioner of Building Control has been obtained confirming that the submitted as-built plans of the piles, whether in whole or in part, are in order; and

b) in the event the Commissioner of Building Control directs for further building works to be carried out in respect of the constructed piles without issuing a written confirmation as described in paragraph 2B(a) above, shall ensure that the further building works are carried out in accordance with the direction of the Commissioner of Building Control and that structural works (including pile caps) above the constructed piles and further building works do not commence until a written confirmation from the Commissioner of Building Control has been obtained confirming that the submitted as-built plans of the piles and further building works, whether in whole or in part, are in order.