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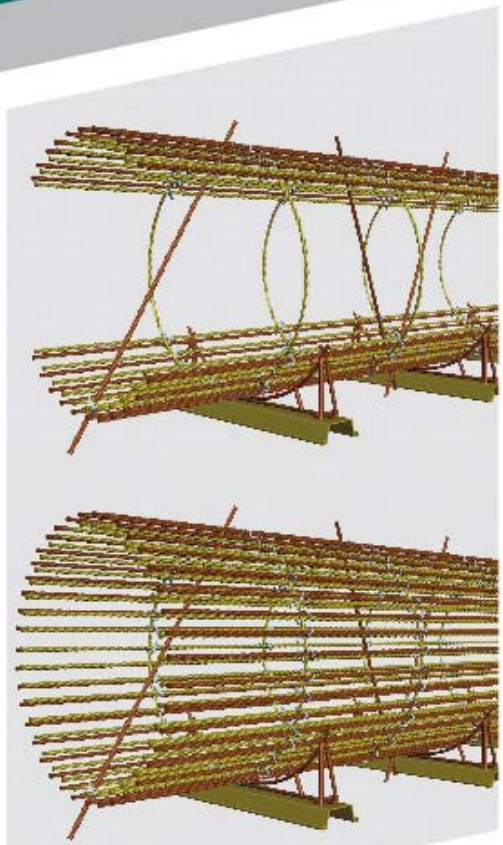

GUIDELINES ON FABRICATION OF REINFORCEMENT CAGES OF BORED PILES

www.hkcic.org

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Disclaimer

Whilst reasonable efforts have been made to ensure the accuracy of the information contained in this publication, the CIC nevertheless would encourage readers to seek appropriate independent advice from their professional advisers where possible and readers should not treat or rely on this publication as a substitute for such professional advice for taking any relevant actions.

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Preface

The Construction Industry Council (CIC) is committed to seeking continuous improvement in all aspects of the construction industry in Hong Kong. To achieve this aim, the CIC forms Committees, Task Forces and other forums to review specific areas of work with the intention of producing Alerts, Reference Materials, Guidelines and Codes of Conduct to assist participants in the industry to strive for excellence.

The CIC appreciates that some improvements and practices can be implemented immediately whilst others may take more time to adjust. It is for this reason that four separate categories of publication have been adopted, the purposes of which are as follows:

Alerts	Reminders in the form of brief leaflets produced quickly to draw the immediate attention of relevant stakeholders the need to follow some good practices or to implement some preventative measures in relation to the construction industry.
Reference Materials	Reference Materials for adopting standards or methodologies in such ways that are generally regarded by the industry as good practices. The CIC recommends the adoption of these Reference Materials by industry stakeholders where appropriate.
Guidelines	The CIC expects all industry participants to adopt the recommendations set out in such Guidelines and to adhere to such standards or procedures therein at all times. Industry participants are expected to be able to justify any course of action that deviates from those recommendations.
Codes of Conduct	Under the Construction Industry Council Ordinance (Cap 587), the CIC is tasked to formulate codes of conduct and enforce such codes. The Codes of Conduct issued by the CIC set out the principles that all relevant industry participants should follow. The CIC may take necessary actions to ensure the compliance with the Codes.

If you have attempted to follow this publication, we do encourage you to share your feedback with us. Please take a moment to fill out the Feedback Form attached to this publication in order that we can further enhance it for the benefit of all concerned. With our joint efforts, we believe our construction industry will develop further and will continue to prosper for years to come.

1. Preamble

1.1 This publication provides general guidance on proper procedures of fabrication of reinforcement cages of bored piles.

1.2 The intention of the Guidelines is to encourage incorporation of the work procedures into the Construction Method Statements of various construction projects, hence enhancing the safety of workers and site safety performance.

1.3 In this publication, details of the requirements and desirable features of the fabrication of reinforcement cages of bored piles are illustrated.

1.4 The CIC recommends the construction industry stakeholders, practitioners and professionals to adopt the steps as set out inside the Guidelines in various construction projects as far as practicable.

2. Definitions

Registered Professional Engineer(s)	It means a registered professional engineer (civil / structural).
Registered Safety Officer (RSO)	It means a person registered as a safety officer under regulation 7 of the Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations (Chapter 59Z).
Bar Fixing Foreman	It means a person who possesses 10 years experience or above in bar fixing, in which 3 years' experience or above should be in the fabrication of similar reinforcement cages.

3. Planning for Fabrication Work

3.1 General

Fabrication of reinforcement cages of bored piles should be properly planned so that the work can be carried out safely and without risk to health. The planning should include detailed risk assessment and method statement for the fabrication work, and the safety precautions to be adopted during all fabrication procedures. Suitable location for the fabrication work should also be identified and designated (a sample of layout plan in Annex 1) with due regard to foreseeable risks.

3.2 Risk Assessment

3.2.1 Prior to the commencement of fabrication, site supervisors, registered safety officers and other personnel concerned should jointly conduct analysis of the potential hazards arising from the fabrication of reinforcement cages and formulate relevant safety measures to ensure the safety of workers. The risk assessment report should include the names and positions of those who conducted the assessment, the date of the assessment, and relevant preventive and protective measures suggested.

3.2.2 The assessment includes evaluation of the stability of the reinforcement cage fabrication location, for example, whether the ground is even; and whether the equipment is safe.

3.2.3 If it is necessary to relocate the fabrication work or there is any significant change, a fresh hazard analysis and risk assessment should be conducted.

4. Work Procedures

4.1 The structure of the fabricated reinforcement cage of bored piles should comply with the method statement and fabrication drawings. The design, risk assessment, fabrication drawings, safety measures, method statement, etc. should be verified, approved and signed off by a Registered Professional Engineer. In addition, the design of the reinforcement cage (such as the need for additional stiffener rings) should take into account the subsequent lifting operation and installation of the reinforcement cage.

4.2 Major machinery, equipment and materials

4.2.1 Construction Machinery include:

(i) Lifting appliances and gear (such as electric or manual chain hoisting blocks and cranes)
(ii) Bar bending and shearing machine(s)
(iii) Welding machine(s)

4.2.2 A sample of inspection record of machinery is shown in Annex 2.

4.2.3 Construction Equipment include:

(i) Ground plate(s)
(ii) Arc-shaped fabrication frames
(iii) Tie-bracings
(iv) Working platforms inside and outside the cage
(v) Wrenches for fastening U-bolts

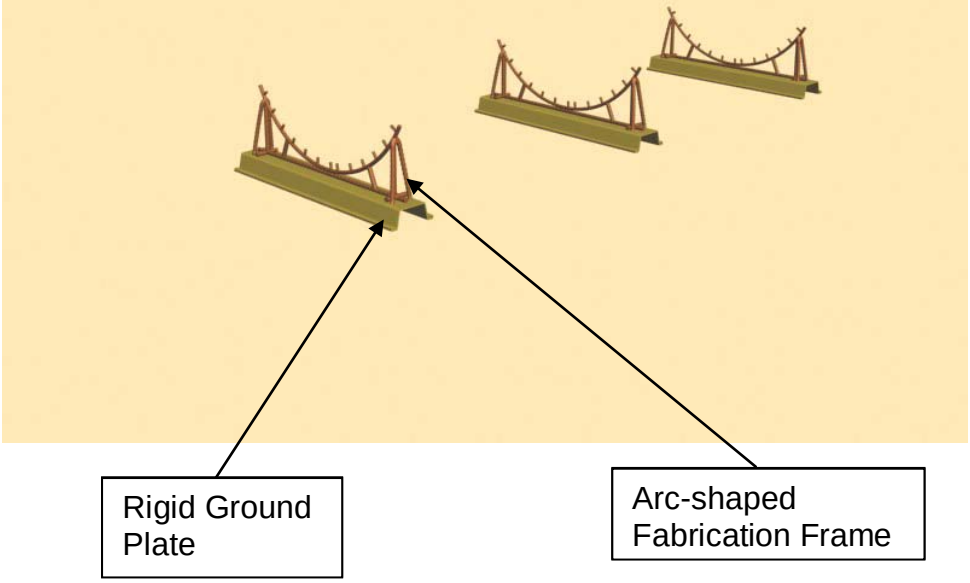
4.2.4 Materials include:

(i) Steel bars
(ii) Stiffener rings

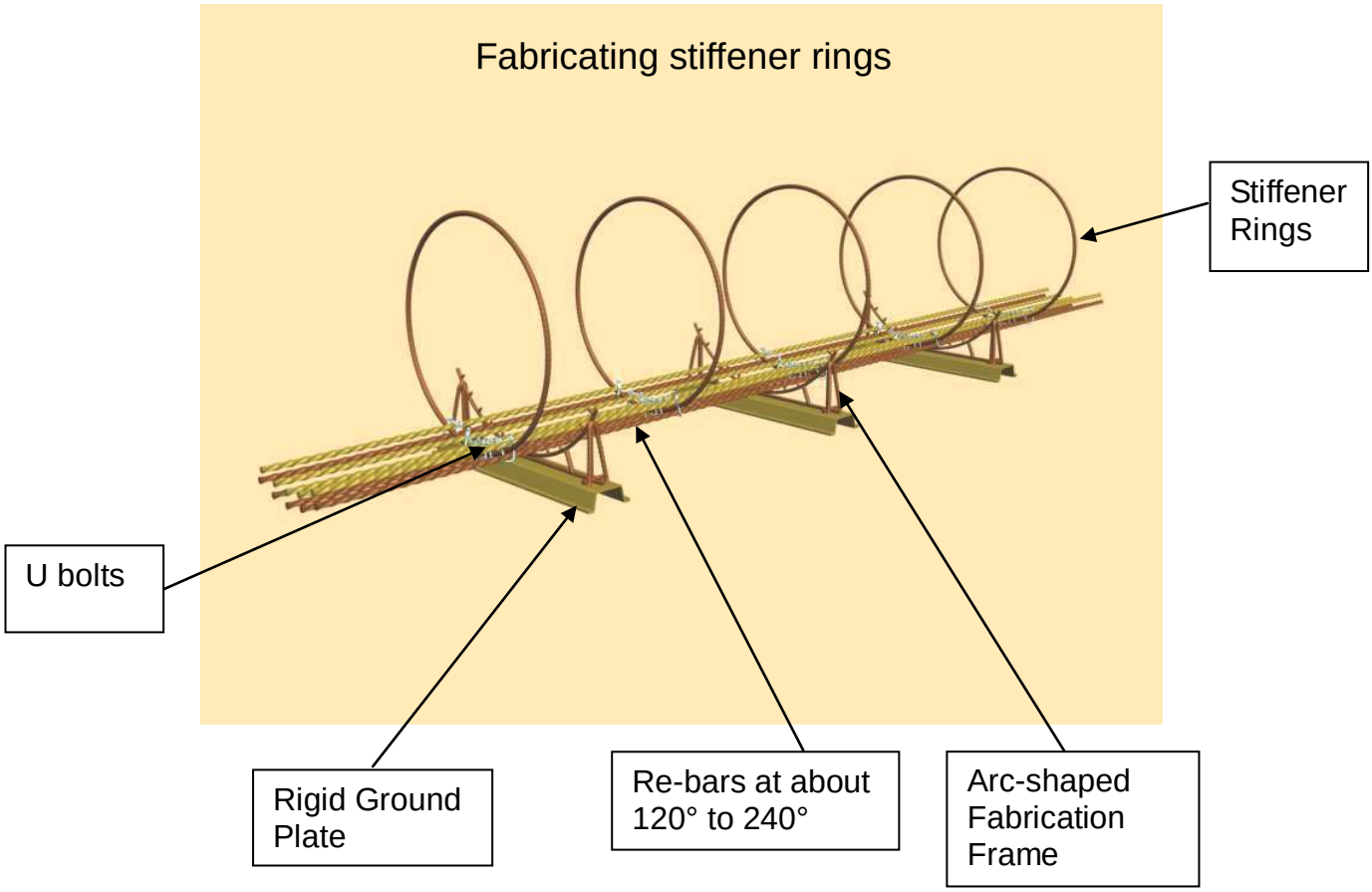
4.3 Work Procedures

(i) Place the arc-shaped fabrication frames on rigid ground plates for supporting the reinforcement cage；

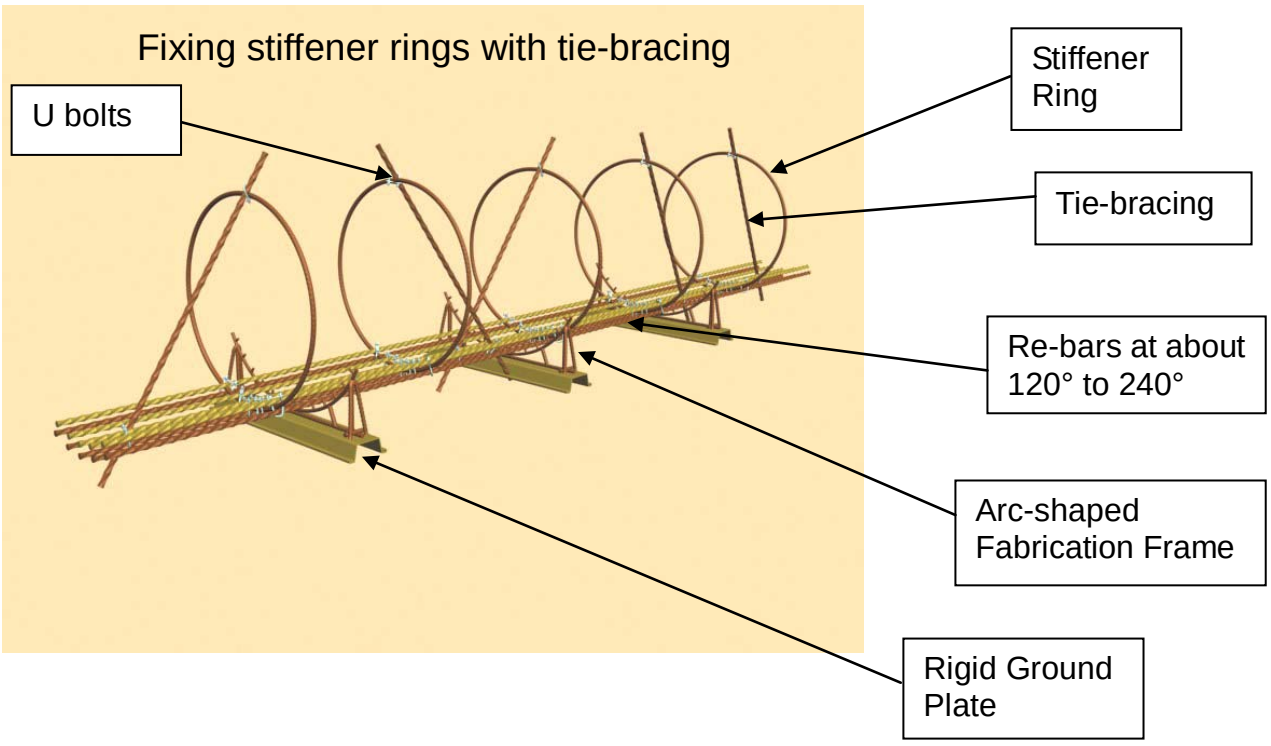
Placing arc-shaped fabrication frames on rigid ground plates for supporting the reinforcement cage



(ii) Upon fixing re-bars with tie wires at a span between 120° to 240° at the bottom of the stiffener rings, immediately fasten all the re-bars (both inside and outside the cage) by U-bolts to the stiffener rings；

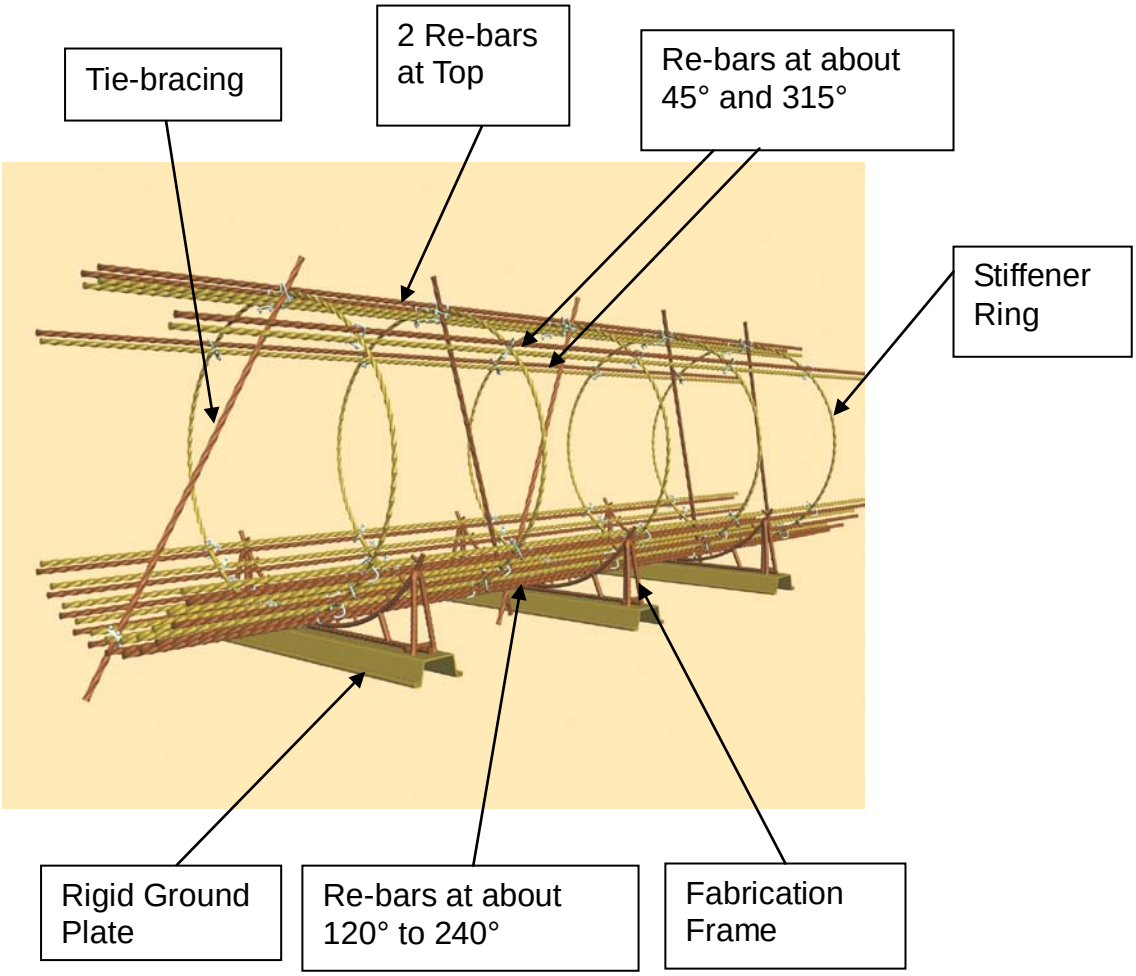


(iii) Use U-bolts to fix at least 2 tie-bracings at the top positions of the stiffener rings at both ends of the cage, and then use U-bolts to fasten sufficient tie-bracings with other stiffener rings inside the cage ;

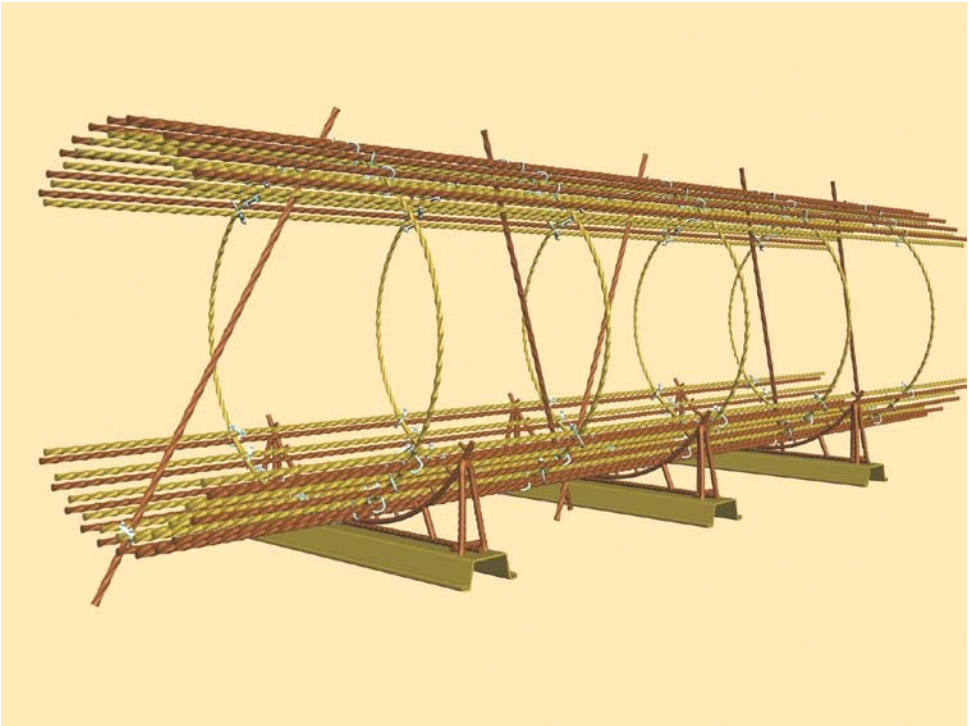


(iv) At about 45° and 315° above the stiffener rings, fasten at least one re-bar both inside and outside the cage by U-bolts ;

(v) At the top of stiffener rings (i.e. 0° / 360°), fasten at least two re-bars both inside and outside the cage by U-bolts ;

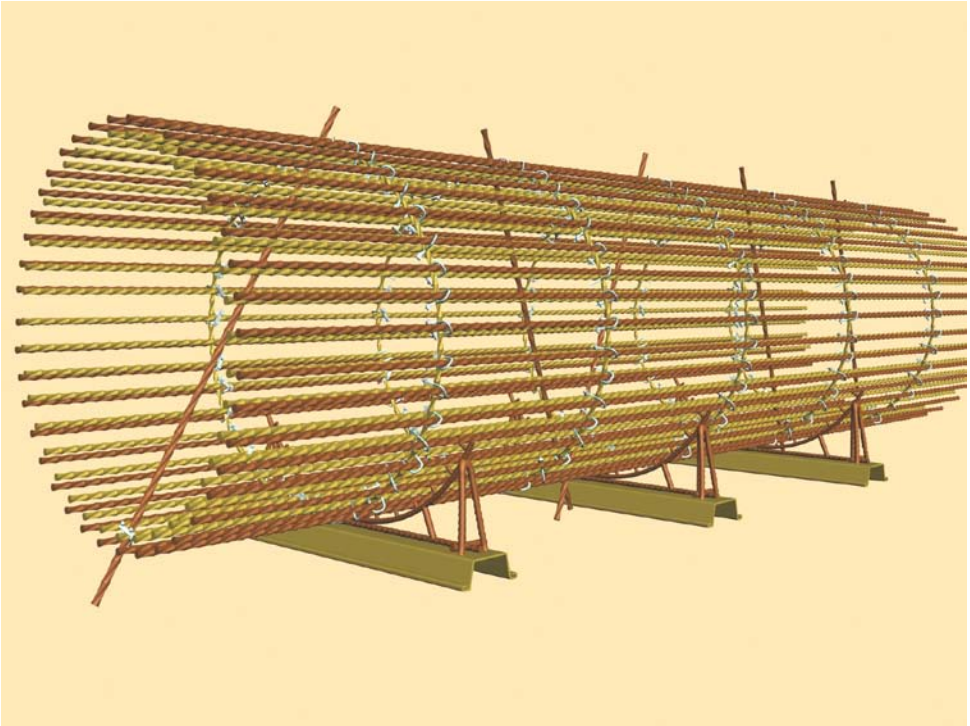


(vi) After fixing tie-wires on the top positions of stiffener rings, fasten re-bars at both sides (i.e. at a span from 45° to 315°) inside and outside the cage by U-bolts ;



(vii) Outside the cage, use tie-wires to fix remaining re-bars at both sides of the stiffener rings, and then use U-bolts to fasten；

(viii) Repeat the above procedures to finish fabrication of all remaining re-bars inside the cage；



(ix) Fasten re-bars with U-bolts at suitable positions of the cage both inside and outside in accordance with the fabrication drawings and complete all the fabrication processes；and

(x) The temporary tie-bracings should only be removed upon inspection and verification of the reinforcement cage by the Bar Fixing Foremen in accordance with the fabrication drawings (including proper fastening of all U-bolts involved).

4.4 The fabrication drawings should clearly illustrate the details about the appearance of a completed reinforcement cage, including the position and number of re-bars, stiffener rings, tie-bracings, U-bolts, etc.

5. Hazards and Control Measures Related to Fabrication of Reinforcement Cages

5.1 Hazards related to fabrication of reinforcement cages include:

(i) Fall of persons
(ii) Falling objects
(iii) Collapse of cage during fabrication
(iv) Strike by moving machineries or against materials
(v) Toppling of cranes
(vi) Manual handling operation
(vii) Electric shock or electrocution
(viii) Work under hot weather

5.2 Control Measures

5.2.1 Ground Plates

(i) At least 3 ground plates for fixing a 12-metre cage should be provided and be placed on an even and rigid ground.
(ii) The length of each ground plate should not be less than the diameter of the cage.

5.2.2 Arc-shaped Fabrication Frames

(i) Arc-shaped fabrication frames should be connected securely on suitable ground plates.
(ii) In accordance with the fabrication drawing, there should be short bars fixed on the 120° arc-shaped rings on ground plate. The base width of a tripod on both sides of the ground plate should not exceed the width of a ground plate.
(iii) These tripods supporting the arc-shaped frames and the bars of the tripods should be connected by welding properly.
(iv) The fabrication frame should be connected properly by welding to the ground plate. The welding joints should be checked regularly and visual inspection to be conducted each time before using the ground plate to ensure that they are in good conditions.

5.2.3 Stiffener Rings and Tie-bracings

(i) Each stiffener ring should be placed vertically and securely, including the use of U-bolts to fasten at least 2 tie-bracings at top positions of stiffener rings at both ends of the cage, and fasten sufficient tie-bracings with other stiffener rings inside the cage by U-bolts.
(ii) The diameter of a tie-bracing should be similar to or larger than that of a re-bar. Tie-bracing should be made up of high tensile steel bar (such as the use of Y32 and Y40 steel bar).

5.2.4 Working at Height

(i) Suitable working platforms should be provided inside and outside the cage for fabrication works, including fixing re-bars at the top positions of stiffener rings to prevent workers falling from height.
(ii) The working platform should be of good construction and of suitable height with proper guard-rails and kickers.

5.2.5 Lifting Operations

(i) Suitable lifting appliances and gear including electric or manual chain hoisting blocks should be used for lifting operations. All appliances and gear should be properly maintained.
(ii) A safe lifting route should be planned to ensure the load would not strike against any workers or objects.
(iii) Lifting appliances and gear should be inspected, tested and examined regularly with valid certificates.
(iv) Operators should be trained and competent, and where appropriate, they should possess valid certificates for lifting operation.
(v) Operators should have a clear and unobstructed view to ensure the lifting route is safe. Signaller should be assigned to give signals to the operators, so as to ensure safe lifting operation.
(vi) Prior to the lifting operation, suitable measures should be taken to ensure the stability of the appliance.
(vii) Suitable safety latches should be provided to the hooks to prevent any parts of the loads from slipping and displacement during lifting operation, thereby causing danger to the workers.
(viii) During the lifting operation, all re-bars must be fastened on

stiffener rings with U-bolts.

(ix) If additional stiffener rings and tie-bracings are needed to be fixed on the cage for lifting, their positions and numbers should be indicated on the fabrication drawings. Those tie-bracings, additional stiffener rings and specific lifting positions should be marked clearly with different color codes for easy identification. The numbers should also be clearly specified.

(x) Tag lines and guide ropes should be provided to assist in controlling the movement and swiveling of loads.

5.2.6 Hand Tools

(i) Provide sufficient and suitable wrenches to fasten U-bolts for proper use.

(ii) Ensure all electrical equipments are safe for use. Use only double-insulated and earthed electrical equipment. Power source should be provided with residual circuit breakers.

(iii) All installation, connection and maintenance of electrical equipment should be carried out by competent and registered electrical workers.

(iv) Connect electric wire securely with proper earthing.

(v) When using electrical equipment, workers should keep their bodies and working area dry. If working in a humid environment is unavoidable, waterproof socket should be used.

(vi) Place electric wires properly to prevent damage by steel bars.

5.2.7 Transportation Arrangement

(i) Plan vehicle driving route, provide sufficient and clear indication.

(ii) Drivers should be aware of the site condition and should not exceed the speed limit.

(iii) Assign personnel as required to give signals to drivers.

(iv) Ensure workers involved wearing reflective vests.

5.2.8 Manual Handling Operation

(i) Provide training to the bar fixing workers.

(ii) Provide the weight of the loads and other required information.

(iii) Implement preventive and protective measures such as

assign sufficient number of workers to handle steel bars.

5.2.9 Personal Protective Equipment

Provision of suitable personal protective equipment to workers, including safety helmets, safety goggles, reflective vests and safety gloves; and ensure that they are properly used and maintained.

5.2.10 Warning Notices

(i) Fencing should be erected and affixed with legible warning notices to prevent construction equipment from hitting by other appliances such as vehicles.
(ii) The cage fabrication area should be fenced off with notices posted to prohibit any unauthorized persons from entering the area.

5.2.11 Hot Weather

Please refer to the Guidelines issued by the Construction Industry Council and Labour Department on hot weather.

6. Information, Instruction, Training and Supervision

6.1 Sufficient Bar Fixing Foremen should be appointed to supervise all working procedures in order to ensure compliance with the method statement (A sample appointment letter of Bar Fixing Foremen in Annex 3).

6.2 Necessary information, instruction and training should be provided so as to ensure safety and health of all workers concerned.

6.3 Fabrication drawings should be disseminated to Bar Fixing Foremen in order to ensure fabrication procedures are followed properly and safely. Prior to the fabrication, Bar Fixing Foremen should give briefing about the method statement and work procedures to all bar fixing workers involved. Bar Fixing Foremen should supervise the reinforcement cage fabrication on site. If safety measures are found to be insufficient, the foreman has the authority to stop the fabrication work.

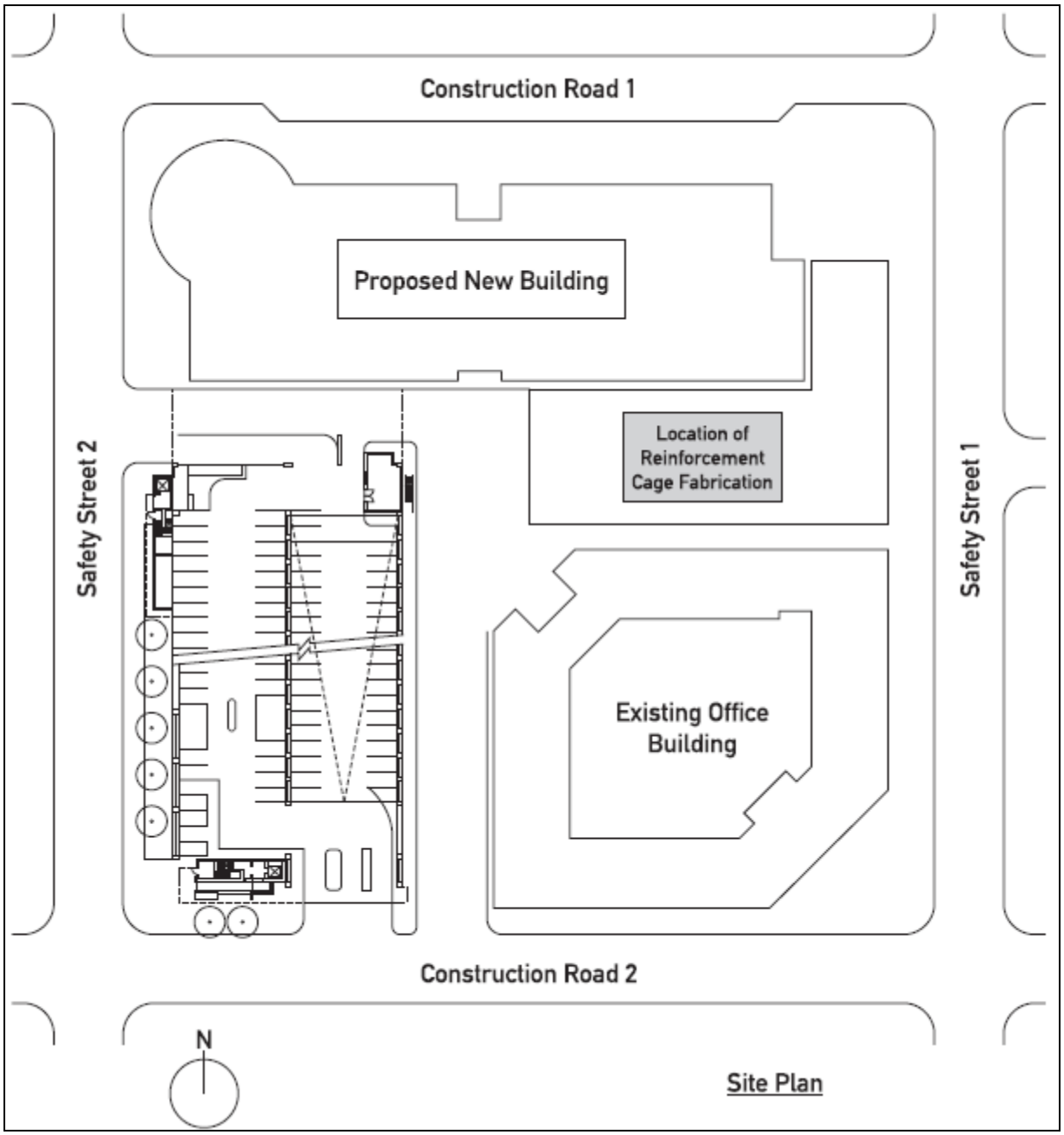
6.4 Upon completion of the fabrication, Bar Fixing Foremen should check whether the reinforcement cages comply with the fabrication drawings before any subsequent lifting operation and installation.

6.5 Project-in-charge should also implement sufficient measures to ensure effective supervision of the work and provide assistance as necessary.

6.6 Safety training for all bar fixing workers should be properly recorded (A sample of safety training record in Annex 4).

Annex 1

Site Layout Plan (Sample)



Annex 2

Inspection Record of Machinery (Sample)

Record No.：_____

Type of Machinery：				
Model：		**Manufacturer's Serial No.：**		
User Company：		**Reference No：**		
Location of Installation /Use：				
Inspection Date：		**Person Responsible for the Inspection：**		
Inspection Details：				
No.	**Item**	**Inspection Summary**	**Results**	**Remarks**
Next Inspection Date:				

Signature: _____

Name: _____

Title: _____

Date: _____

Annex 3

Appointment Letter for Bar Fixing Foremen (Sample)

Name of Construction Site:_____

Project Name: _____

The Company appoints the following persons as the Bar fixing Foremen on the aforementioned construction site from _____ to _____. The personnel possesses 10 years' experience or above in bar fixing, in which 3 years' experience or above is in the fabrication of similar reinforcement cages.

Name	Company	Green Card	Relevant Experience	Certificates of Relevant Work

Signature and Company Chop: _____

Name: _____

Title: _____

Date: _____

Annex 4

Safety Training Record (Sample)

Name of construction site : _____

Project Name : _____

Training Date : _____

Training Venue : _____

Training Content : _____

Speaker : _____

Speaker's Qualification and Experience : _____

Signature of Participants:

I hereby clearly understand the aforementioned work procedures and safety rules, and shall strictly comply them to ensure other workers and I should work in a safe and healthy environment.

Name	**Signature**	**Date**

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Feedback Form
[GUIDELINES on Fabrication of Reinforcement Cages of Bored Piles]

Thank you for reading this publication. To improve our future editions, we would be grateful to have your comments.

(Please put a "✓" in the appropriate box.)

1. As a whole, I feel that the publication is:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Informative	❑	❑	❑	❑	❑
Comprehensive	❑	❑	❑	❑	❑
Useful	❑	❑	❑	❑	❑
Practical	❑	❑	❑	❑	❑

2. Does the publication enable you to understand more about the Fabrication of Reinforcement Cages of Bored Piles?	Yes	No	No Comment
	❑	❑	❑
3. Have you made reference to the publication in your work?	Quite Often	Sometimes	Never
	❑	❑	❑
4. To what extent have you incorporated the recommendations of the publication in your work?	Most	Some	None
	❑	❑	❑

5. Overall, how would you rate our publication?	Excellent	Very Good	Satisfactory	Fair	Poor
	❑	❑	❑	❑	❑

6. Other comments and suggestions, please specify (use separate sheets if necessary).

Personal Particulars (optional):*

Name: Mr. / Mrs./ Ms./ Dr./ Prof./ Ir / Sr ^

Company: _____

Tel: _____

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* The personal data in this form will be used only for this survey. Your data will be kept confidential and dealt with only by the Construction Industry Council.

^ Circle as appropriate.

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