Thank you for ACES' continued support of our work. Please find attached the final circular, which will be published on 1 September 2026, for your necessary action where applicable.

Thanks much.

Willie Chai
Senior Engineer
Bridges and Structural Steel Department
Building Engineering Group

Building and Construction Authority
T: 6804 4579

Building and Construction Authority

An MND Statutory Board
52 Jurong Gateway Road #11-01 Singapore 608550
Tel. 1800 3425 222
www.bca.gov.sg

In Collaboration With

ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE

THE INSTITUTION OF ENGINEERS · SINGAPORE ·

Our Ref: APPBCA-2026-15

1 September 2026

For enquiries, please contact:
Building Engineering Group (#10-01)
by using our online feedback form at:
https://www2.bca.gov.sg/feedback/

Dear Sir/Madam

JOINT BCA/ACES/IES CIRCULAR 2026
KEY CONSIDERATIONS FOR POST-INSTALLED ANCHORS

Objective

This circular serves to remind industry stakeholders of the key considerations for the design and construction of connections using post-installed anchors to ensure structural safety.

Background

2. Proper installation of post-installed anchors (PIAs), together with appropriate design and construction practices, is essential to ensure that PIAs perform as intended. Despite their widespread use, BCA has observed recurring shortcomings in the design and construction of PIAs that have resulted in structural deficiencies. To promote consistent engineering practice and enhance structural safety, BCA has worked with Association of Consulting Engineers Singapore (ACES) and the Institution of Engineers, Singapore (IES) to consolidate the key considerations for PIAs into this circular. Annex A provides practical guidance on connection design, material selection, product qualification, installation and quality assurance considerations for PIAs.

3. Qualified Persons (QPs) shall incorporate these key considerations into their designs and ensure that they are properly implemented during construction. QPs have duties under the Building Control Act to take all reasonable steps and exercise due diligence to ensure that building works under their purview are designed and constructed in accordance with the Building Control Act and its subsidiary building regulations.

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Tel. 1800 3425 222
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4. Builders shall install all PIAs in accordance with the approved plans and supervised by the QP's site supervisor. Where site conditions differ from those assumed in the approved design, or installation cannot be carried out in accordance with the approved plans, the QP shall be notified and consulted before any changes are made. Any deviation from the approved plans, including changes to the PIA type, location, configuration or drilled depth, without the QP's concurrence, is strictly prohibited.

For Clarification

5. We would appreciate it if you could bring the content of this circular to the attention of your members. Should you require clarification on this matter, you may contact us through our online feedback form at: https://www2.bca.gov.sg/feedback/.

Yours faithfully

ER. LUNG HIAN HAO
DIRECTOR
BUILDING ENGINEERING GROUP
BUILDING AND CONSTRUCTION AUTHORITY
for COMMISSIONER OF BUILDING CONTROL

ER. YONG FEN LEONG
CHAIR, C&S PRACTICE
ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE

ER. DAVID NG CHEW CHIAT
CHAIR, C&S TECHNICAL COMMITTEE
THE INSTITUTION OF ENGINEERS SINGAPORE

Annex A – Key Considerations for Post-Installed Anchors

1. Connection Types

Tension or hanging structures are particularly prone to disproportionate collapse. If any tension member or tension connection fails, there is no guarantee that the load can be safely redistributed to the remaining tension members. This is because the load in each tension member is highly influenced by construction imperfections. Several cases have been reported internationally where the failure of a single member triggered the collapse of the entire structure with catastrophic consequences.

Shear connections are therefore preferred where practicable, as they provide greater robustness as prescribed in Clause 5.2(c) of BS 8539[1]. This can be achieved by rearranging the connection such that loads are transferred predominantly in shear, for example by connecting to the vertical face of the supporting member instead of its horizontal face, as illustrated in **Figure A.1**, so that the applied load is transferred laterally through the PIA in shear rather than axially in tension. It should be noted, however, that shear connections also require proper design in accordance with SS EN 1992-4[2] to function as intended. In particular, anchors located near concrete edges may be governed by concrete edge breakout, which is a brittle mode of failure that must be carefully considered in design (see Section 9 of this Annex for further details). Where a predominantly shear connection cannot be achieved due to geometric or structural constraints, the considerations in Section 2 of this Annex shall apply.

Figure A.1: Example of how a tension connection (left) can be converted into a shear connection (right) to provide greater robustness

2. Tension Connections

For tension connections, the following considerations shall be taken into account:

- Loads experienced by a tension connection (**Figure A.2**) are highly influenced by construction imperfections. Hence, sufficient redundancy should be provided for tension connections in accordance with Clause 5.2(c) of BS 8539[1], such as by considering the failure of a single PIA or tension member, or by applying higher safety factors, such that one isolated failure of a single PIA or tension member does not result in the overloading of other PIAs or tension members, leading to progressive collapse.

- To mitigate potential weaknesses in tension connections, the use of cast-in connections in lieu of post-installed connections is recommended for new construction where practicable.

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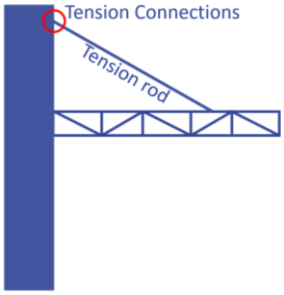


Figure A.2: Examples of tension connections requiring redundancy consideration

3. Derivation of Resultant Forces

Eccentricity in connections influences the derivation of resultant forces. Hence, it is essential to consider the applicable eccentric forces in accordance with Clause 6.1 of SS EN 1992-4[2], and the use of the correct lever arm based on the structural configuration, as illustrated in **Figure A.3**.

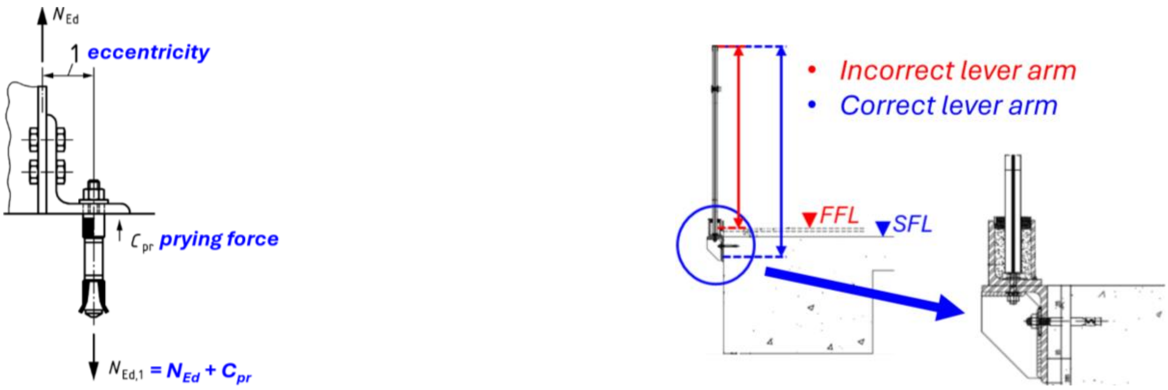


Figure A.3: Key considerations in the derivation of resultant forces – (left) example of amplification of tension forces acting on PIA due to eccentricity; (right) example of the correct lever arm consideration for a barrier connection in the determination of design forces for bending moment

4. Arrangement of Anchors

The arrangement of anchors significantly influences the force distribution within an anchor group, particularly for moment-resisting connections. Where feasible, anchors should be arranged to maximise the effective lever arm as illustrated in **Figure A.4**. This generally reduces the tensile forces on individual anchors and improves the robustness of the connection.

Figure A.4: Example of a more favourable anchor arrangement

In addition, moment-resisting connections can be subjected to load reversal, and bending can therefore occur in either direction. Hence, a minimum of two rows of anchors is generally required to ensure adequate resistance, as shown in **Figure A.5**.

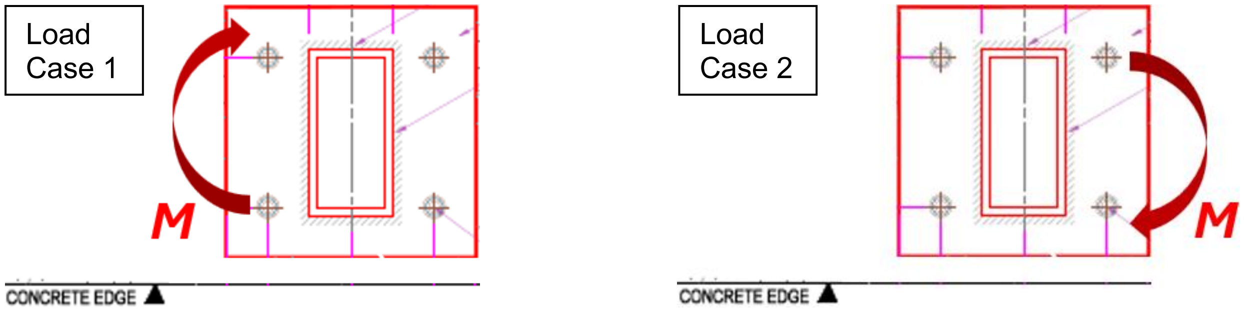


Figure A.5: Minimum of two rows of anchors for moment-resisting connections subjected to bending in either direction due to load reversal

5. Base Plate Rigidity

Base plate rigidity significantly influences the distribution of forces within an anchor group. For thin or flexible base plates, the assumption of rigid base plate behaviour is generally not valid as the deformation of the plate may alter the force distribution and generate additional tensile forces in the anchors due to prying action, as illustrated in **Figure A.6** and as prescribed in Clause 6.1 of SS EN 1992-4[2]. Therefore, the distribution of forces must be evaluated based on the actual base plate rigidity, and the assumption of rigid base plate behaviour should not be adopted unless it can be justified.

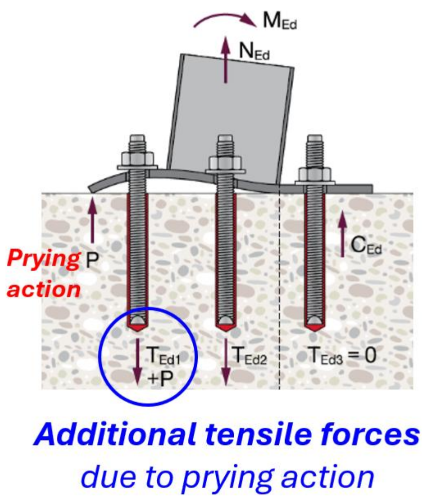


Figure A.6: Additional tensile forces due to prying action from base plate deformation

6. Material Selection

Proper material selection is essential to ensure anchor performance and durability over its intended service life. The material grade and corrosion protection system should be selected according to the environmental exposure conditions and the intended service life in accordance with Table 1 of BS 8539[1].

For external applications, including façade and cladding fixings exposed to weathering, corrosion-resistant stainless steel anchors should generally be specified to achieve the required durability, as also prescribed in the Approved Document issued under the Building Control Regulations. In more aggressive environments, such as marine or high-chloride exposure conditions, higher corrosion-resistant materials (e.g. high-corrosion-resistant stainless steel) should be considered where appropriate. The mechanical and physical properties shall conform to approved standards (e.g. BS EN ISO 3506-1[3] and BS EN 10088-1[4]).

7. Product Qualification

PIA products are qualified through the European Technical Assessment framework, where products are evaluated against the relevant European Assessment Document (EAD) and granted a European Technical Assessment (ETA) upon satisfying the prescribed requirements. The ETA, issued by a Technical Assessment Body, serves as the product's technical certificate, confirming its compliance with the qualification criteria and providing the design parameters necessary for use in accordance with SS EN 1992-4[2], as well as installation procedures and usage limitations.

It is important to note that not all PIA products, despite having an ETA, are equivalent, as the scope of qualification is product dependent. Certain assessments, including seismic, fire and crack testing, are optional, and not all products have undergone these evaluations. Only products that have been assessed for these conditions will have corresponding design values stated in their ETA. Furthermore, even among products qualified for the same conditions, the design values can vary significantly from product to product. Therefore, the suitability of a PIA product must be verified against the specific scope of qualification stipulated in its ETA, and detailed design must be carried out for the PIA product that is proposed for use.

Given that Singapore has adopted the Eurocodes, ETAs issued under the European Technical Assessment framework are compatible with local design standards and are accepted as meeting the performance requirements prescribed under the Building Control Regulations. Accordingly, PIA products used in Singapore should hold a valid ETA issued under the relevant EADs, depending on the type of PIA and its intended application (e.g. EAD 330232[5] for mechanical anchors, EAD 330499[6] for bonded anchors and EAD 330250[7] for fatigue cyclic loading).

8. Condition of Base Material – Cracked or Uncracked Concrete

Concrete is likely to develop cracks within allowable limits (e.g. 0.30 mm under certain exposure conditions per SS EN 1992-1-1[8]) over its service life due to various effects such as bending, shear, creep, and shrinkage. It is therefore more appropriate to assume cracked concrete conditions when designing PIAs, as recommended in Clause 4.7 of SS EN 1992-4[2].

Clause 4.7 of SS EN 1992-4[2] permits the assumption of uncracked concrete conditions, provided it can be demonstrated that under the characteristic combination of loading at the serviceability limit state, the PIA with its entire embedment depth is located in uncracked concrete. This is to be demonstrated by showing that the total stress in the concrete due to external loads and restraint of imposed deformations, computed using Formula 4.4 of SS EN 1992-4[2], is less than the admissible tensile stress (recommended value $\sigma_{adm} = 0$ based on characteristic combination of loading at serviceability). It should be noted that this condition is particularly difficult to satisfy in practice for structural elements subject to live loads, thermal effects, or other variable actions. Therefore, it is good engineering practice to assume cracked concrete conditions, as noted in Clause 4.7 of SS EN 1992-4[2], unless uncracked concrete conditions can be demonstrated through documented calculations. In this regard, visual inspection is not sufficient to justify such an assumption.

As crack testing under the EAD is an optional assessment, not all PIAs are qualified for use in cracked concrete, as illustrated in **Figure A.7**. It is therefore essential that the proposed product is verified against its ETA to confirm its suitability for use under cracked concrete conditions where such conditions are assumed in the design.

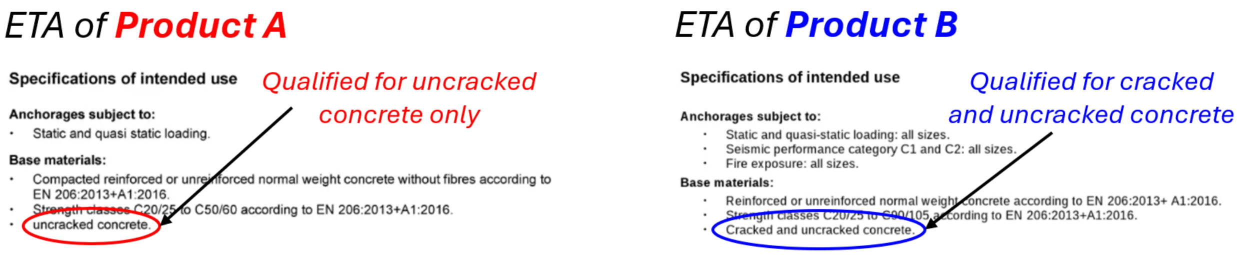
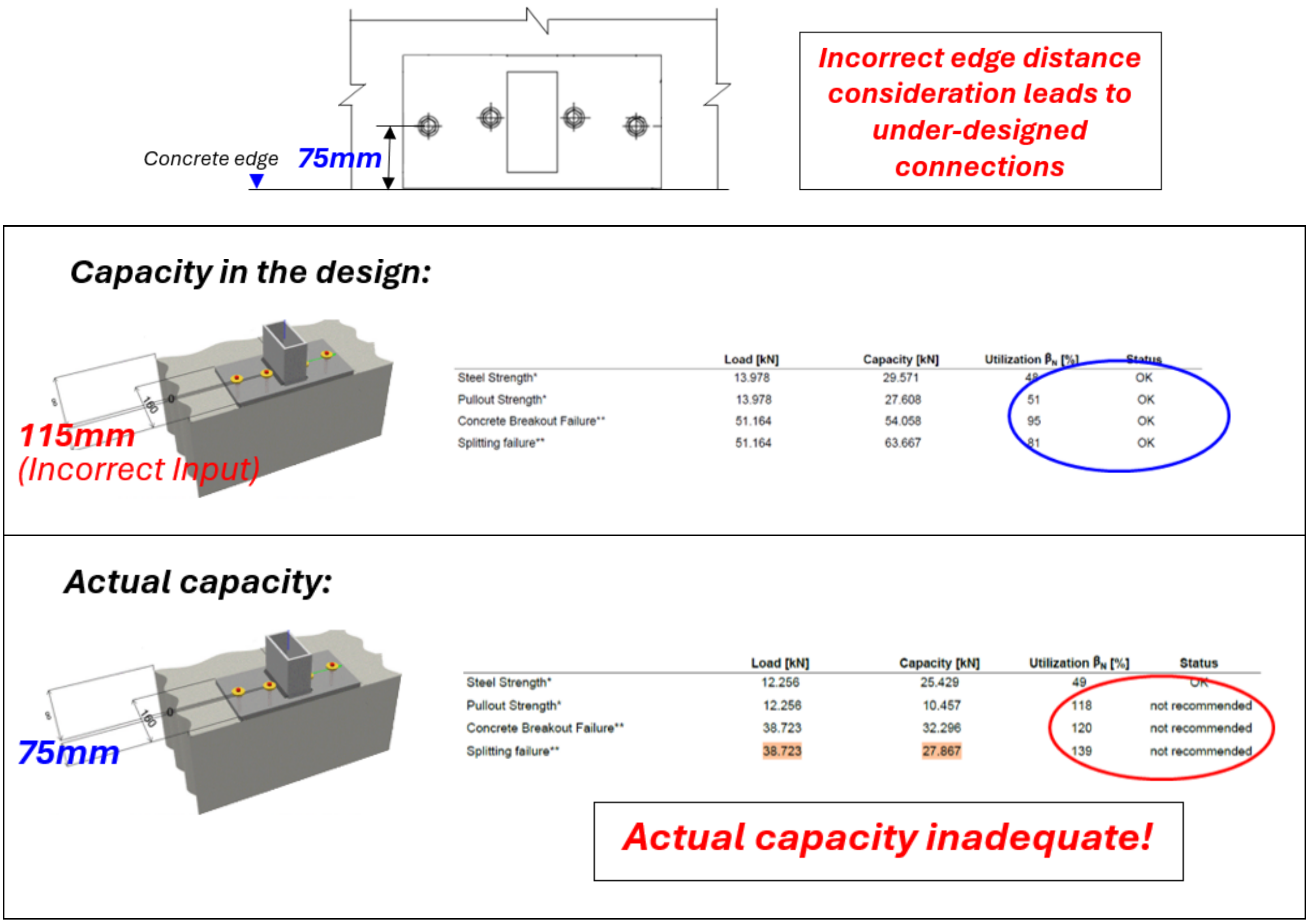


Figure A.7: Example of a product ETA showing that not all PIAs are qualified for use in cracked concrete conditions

9. Edge Distance and Spacing

Insufficient edge distance can lead to concrete edge breakout or splitting failure, both of which are brittle modes of failure that can significantly reduce the capacity of the connection. Similarly, insufficient spacing between anchors can lead to group effects that reduce the overall capacity of the connection. It is therefore essential that edge distances and spacing are carefully determined in the design. Incorrect assumptions can result in an under-designed connection, as illustrated in **Figure A.8**.



	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel Strength*	13.978	29.571	48	OK
Pullout Strength*	13.978	27.608	51	OK
Concrete Breakout Failure**	51.164	54.058	95	OK
Splitting failure**	51.164	63.667	81	OK

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel Strength*	12.256	25.429	49	OK
Pullout Strength*	12.256	10.457	118	not recommended
Concrete Breakout Failure**	38.723	32.296	120	not recommended
Splitting failure**	38.723	27.867	139	not recommended

Figure A.8: Example of how incorrect edge distance assumption can lead to an under-designed connection

10. Use of Engineering Software

PIA design involves various interdependent variables, such as base concrete conditions, edge distances, anchor spacing, group anchor effects, base plate rigidity, installation parameters and product ETA data, that are highly prone to human input errors when calculated manually or through unverified spreadsheets. Anchor groups subjected to combined loading or complex connection geometries are particularly challenging to analyse accurately using such approaches. Furthermore, relying on summarised resistance tables from manufacturers' catalogues is generally not appropriate, as these catalogues have limitations and may not fully capture the site-specific boundary conditions and the required design considerations. Given the complexity of PIA design and the many interdependent design variables, QPs are strongly encouraged to use dedicated PIA design software to execute the design, ensuring that force distributions and failure modes are correctly assessed. This reduces the risk of errors and helps ensure that design parameters are applied consistently.

11. Removal of Plaster Layer and Carbonated Concrete

The embedment depth of PIAs shall be measured from the surface of sound base concrete. As such, any plaster layer and carbonated concrete must be removed prior to PIA installation. This is a critical requirement that shall be clearly indicated on the approved drawings and closely supervised, as incidents where the plaster layer was not removed, leading to inadequate embedment depth, have resulted in reduced PIA capacity and failure.

12. Installation

The performance of PIAs relies critically on correct installation. Improper installation – such as inadequate hole cleaning or setting torque – can significantly reduce anchor capacity. Installation must therefore be carried out in accordance with the construction documents, manufacturer's product installation instructions, instructions in the product ETA, and/or the system's instructions for use, which should be obtained from the product's manufacturer. These documents cover essential installation procedures such as prescribed drilling methods, hole cleaning requirements, injection and curing procedures, and the application of setting torque using approved torque control equipment where applicable. Adherence to these procedures is crucial to ensure installation safety and the performance of PIAs.

13. On-Site Testing

On-site testing is intended to verify the quality of installation rather than the performance of the PIA product. The quality of installation is critical to the performance of the PIA system. In Singapore, where a certified installer scheme is absent, on-site testing serves as an important measure to validate installation quality. Guidance on recommended test frequency and test regimes is provided in the National Annex to SS EN 1992-4[9] and BS 8539[1] respectively. As project requirements may differ, the QP, who has statutory responsibility for the structural safety of the building works, should determine the appropriate sampling rates. It is also recommended as good site practice that on-site testing be carried out by a Singapore Accreditation Council (SAC)-accredited laboratory, as prescribed in the 'Guide Book for Site Supervision Plan'[10].

On-site testing should not be misconstrued as product performance verification. The performance of PIAs with ETA has already been assessed and certified under the relevant EAD referenced in the product ETA. On-site testing serves to validate installation quality and compliance with the manufacturer’s installation requirements, rather than to assess the characteristic performance of the PIA system or to compare products for approval. This is because crucial PIA characteristics such as load-displacement behaviour, creep, durability, suitability in cracked concrete, performance under short-term and long-term temperatures, corrosion resistance, fire performance, and long-term stability cannot be adequately assessed through on-site testing.

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14. Related BCA Circulars on Post-Installed Connections

As a quick guide, the following is a tabulation of past circulars issued by BCA on this subject matter.

Date	Circular Ref No.	Title of Circular
1 Oct 2014	APPBCA-2014-13	BS 8539 – Standard on the Use of Post-Installed Anchors for Structures Requiring Plan Approval
1 May 2017	APPBCA-2017-07	Advisory on the Use of Cladding Materials and Fixings for Building Facades
1 Dec 2022	APPBCA-2022-26	New Singapore Standard SS EN 1992-4:2021 – Design of Fastenings for Use in Concrete
3 Mar 2025	APPBCA-2025-05	Practical Guide for Post-Installed Reinforcement

References

[1] British Standards Institution (2012) *BS 8539:2012+A1:2021 Code of Practice for the Selection and Installation of Post-Installed Anchors in Concrete and Masonry*. London: BSI

[2] Enterprise Singapore (2021) *SS EN 1992-4:2021 Eurocode 2: Design of Concrete Structures – Part 4: Design of Fastenings for Use in Concrete*. Singapore: Enterprise Singapore

[3] British Standards Institution (2020) *BS EN ISO 3506-1:2020 Fasteners – Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners – Part 1: Bolts, Screws and Studs*. London: BSI

[4] British Standards Institution (2023) *BS EN 10088-1:2023 Stainless Steels – List of Stainless Steels*. London: BSI

[5] European Organisation for Technical Assessment (2016) *EAD 330232 Mechanical Fasteners for Use in Concrete*. Belgium: EOTA

[6] European Organisation for Technical Assessment (2017) *EAD 330499 Bonded Fasteners for Use in Concrete*. Belgium: EOTA

[7] European Organisation for Technical Assessment (2021) *EAD 330250 Post-Installed Fasteners in Concrete under Fatigue Cyclic Loading*. Belgium: EOTA

[8] Enterprise Singapore (2015) *SS EN 1992-1-1:2008 Eurocode 2: Design of Concrete Structures – Part 1-1: General Rules and Rules for Buildings*. Singapore: Enterprise Singapore

[9] Enterprise Singapore (2021) *NA to SS EN 1992-4:2021 Singapore National Annex to Eurocode 2: Design of Concrete Structures – Part 4: Design of Fastenings for Use in Concrete*. Singapore: Enterprise Singapore

[10] Building and Construction Authority, The Institution of Engineers, Singapore and Association of Consulting Engineers Singapore (2023) *Guide Book for Site Supervision Plan*. Singapore: BCA, IES and ACES.