

Curtain Wall, Window and Window Wall

Structural Submission of Curtain Wall Plans

Curtain wall shall be designed to meet the specific requirements set out in regulation 43 of the Building (Construction) Regulations (B(C)R). In addition, attention should be paid to the requirements for wind loads, horizontal imposed loads specified in Table 3 of regulation 17(3) of the B(C)R on curtain wall when there is no protective barrier provided, protection of openings, protection against corrosion and the quality of materials.

2. The following details are required to be included in the curtain wall plans for submission to the Building Authority (BA) for approval:

- (a) structural framing and key structural details and the installation procedures excluding any unnecessary shop fabrication details;
- (b) structural calculations comprising design check on the parent structure, analysis on the structural adequacy and stability of the proposed curtain wall, element design for aluminium alloy, fixing components, glazing, and deflection check on major load carrying members;
- (c) workmanship specifications for welding, galvanisation measures to overcome bi-metallic effects, and corrosion prevention;
- (d) elevations including pane arrangements;
- (e) typical and non-typical sections showing structural members and supports;
- (f) typical and non-typical connections;
- (g) specifications on allowable tolerance of the positioning of curtain wall supports and any remedial arrangements in cases where such tolerance is exceeded;
- (h) the mode of support from and connection to the load-bearing structure of the building (anchorage in structural concrete members or welded connections to structural steel members) and any justification and application for modification of regulation 43 of the B(C)R for using other mode of support, e.g. drilled or bolted fixings;

- (i) the projection of the curtain wall from the outer face of the structural elements, e.g. beams, columns and floor slabs, for consideration of exemption from gross floor area and site coverage calculations;
- (j) standards or codes of practice;
- (k) material specifications for structural steel, aluminium alloy, cast-in anchors, fixing screws, structural sealant, and glazing; and
- (l) sections showing compliance with regulation 90 of the B(C)R and the Code of Practice for Fire Safety in Buildings 2011 on such relevant aspects as the protection against spread of fire and smoke between floors, between different fire compartments on the same floor, and between the accommodation of a storey and the required staircase or its protected lobby.

Structural Submission of Window or Window Wall Plans

3. In general, window and window wall should satisfy the performance requirements stipulated in the B(C)R, the requirements on lighting and ventilation stipulated in the Building (Planning) Regulations (B(P)R) and relevant codes of practice.

4. If a window or window wall is at a location where the design wind pressure, q_z , is 2.86 kPa or above and forms wholly or partly the external wall of a building as well as having structural opening with least dimension exceeding 1.8m or an area exceeding 6m², structural framing and key structural details, excluding any unnecessary shop fabrication details should be submitted for approval. The submission should contain the following information to demonstrate that the window or window wall is of adequate strength and stability:

- (a) information described in items (b) to (g) and (j) to (l) of paragraph 2 above;
- (b) structural adequacy in resisting horizontal imposed loads specified in Table 3 of regulation 17(3) of the B(C)R for the window or window wall that functions as a protective barrier; and
- (c) deflection checks to ensure that the maximum deflection of the structural elements does not exceed the deflection limits stipulated in the Code of Practice for Structural Use of Glass 2018 (Glass Code).

5. Structural details of a window or window wall (including glass shop front) with the design span of its structural elements (i.e. mullion, glass fins, etc.) exceeding 6m should be submitted for approval. The structural information mentioned in items (a) to (c) of paragraph 4 above should be included in the submission.

6. Where the structural details of a window and window wall are not required to be submitted for approval, the Authorized Person (AP) and Registered Structural Engineer (RSE) should ensure that the design, fabrication and installation of the window and window wall would achieve the required safety standard. Attention should be given to the requirements on horizontal imposed loads, protection of openings, function of protective barriers, corrosion protection, quality control of materials and protection against the spread of fire and smoke between floors.

Minor Works Relating to Window or Window Wall

7. Under the Minor Works Control System, certain works relating to window or window wall in an existing building have been designated as minor works items, which may be carried out under the simplified requirements as an alternative to obtaining prior approval and consent from the BA. For the list of minor works items and the simplified requirements, please refer to Schedule 1 of the Building (Minor Works) Regulation and Practice Note for AP, RSE and Registered Geotechnical Engineers (PNAP) APP-147 respectively.

Design and Construction Standards

8. Standards commonly used for the design and construction of curtain wall, window and window wall, which are acceptable to the BA, are given in Appendix A and PNAP APP-53.

Separate Registered Structural Engineer

9. In view of the specialty of curtain wall, window and window wall works, a separate RSE may be appointed to prepare the design and supervise the carrying out of such works. Under such circumstances, the specified Forms BA4 and BA5 indicating the appointment of the separate RSE and the scope of works for which he/she is responsible are required to be submitted together with the plans submitted for approval. Upon completion of the works, the separate RSE so appointed is required to certify satisfactory completion of the works in accordance with regulation 25(3) of the Building (Administration) Regulations (B(A)R).

10. Where structural details for proposed curtain wall, window or window wall works are submitted by the separate RSE, the submission should be accompanied by an assessment report prepared by him/her giving an account of the effect of the proposed works to the parent structure. The assessment report should be appended with a statement signed by the project RSE to confirm that he/she is fully aware of the connection details and the effect of the works on the parent structure.

11. The separate RSE appointed for the curtain wall, window or window wall works shall be responsible for the supervision of the construction of such works, including the installation of any cast-in anchorage, e.g. anchor plates, cast-in embeds and through bolts, etc., in the parent structure except in the event where the cast-in anchorage has been pre-installed in the parent structure prior to his/her appointment. For such cases, the structural details and layout of the pre-installed parts should be given in the superstructure plans to be submitted for approval by the project RSE who shall then be responsible for the supervision of the installation of such parts. The separate RSE should refer to the pre-installed connection details when designing the curtain wall, window or

window wall works and should co-ordinate with the project RSE for any necessary amendments if different connection details are to be used.

Use of Tempered Glass

12. Where tempered glass is used, the RSE and the registered contractor (RC) should ensure that an acceptable Quality Assurance Scheme (QAS) is adopted by the glass manufacturer to minimise the risk of spontaneous breakage of tempered glass.

13. To ensure that the tempered glass panes are of good quality, proper supervision and adequate quality control are necessary during the production processes of the tempered glass panes. In this connection, the following conditions/requirements will be imposed when giving approval of plans:

Quality assurance

- (a) the tempered glass should be manufactured by a factory with ISO 9001 quality assurance certification as required under item 6 of section 17(1) of the Buildings Ordinance (BO);
- (b) a copy of the QAS of the manufacturer should be submitted at least 14 days before the commencement of the production works in the factory as required under regulation 10 of the B(A)R. Such submission should be appended with a statement signed by the RSE to declare that he/she has studied the QAS and confirm that there are adequate measures incorporated in the QAS to ensure the quality of the tempered glass products in compliance with the provisions of the BO and the approved plans. The items to be included in the QAS are listed in clause 9.1.3 of the Glass Code;
- (c) the compliance reports for heat soak process¹ issued by the glass manufacturer and endorsed by the RSE should be submitted prior to the application for occupation permit or the submission of Form BA14 as appropriate under regulation 10 of the B(A)R. The compliance reports for heat soak process should be in accordance with clause 9.3 of the Glass Code;

Quality supervision plan

- (d) a quality supervision plan by the RSE and the RC should be submitted as required under item 6 of section 17(1) of the BO for the quality supervision of manufacturer's heat soak process of the tempered glass to be used in the works shown in the approved plans. The required quality supervision should cover-

/(i) ...

¹ As one of the quality control measures for tempered glass used in curtain wall, window and window wall works, heat soak process conforming to BS EN 14179-1:2016 and complying with the Glass Code should be carried out to all tempered glass panes.

- (i) the RSE should assign a quality control supervisor to supervise a certain number of tempered glass panes undergoing the heat soak process. The RSE should determine the necessary frequency of supervision, which should cover at least 30% of the number of tempered glass panes used in the project. The minimum qualifications and experience of the quality control supervisor are to be the same as grade T3 technically competent person (TCP) under the RSE's stream, as stipulated in the Code of Practice for Site Supervision 2009 (Supervision Code);
- (ii) the RC should assign a quality control supervisor to provide full time continuous supervision of the heat soak process of all tempered glass panes in the factory. The minimum qualifications and experience of the quality control supervisor are to be the same as grade T1 TCP under the RC's stream, as stipulated in the Supervision Code. To ensure the heat soak process is properly conducted by the glass manufacturer, the quality control supervisor should measure the glass surface temperature independently by using his/her own data logger. The information recorded by the data logger should be set at one-minute intervals and kept in the factory; and
- (iii) the names and qualifications of the quality control supervisors of the RSE and the RC respectively should be recorded in an inspection log book. The details of heat soak process for tempered glass panes should be recorded in the log book and kept in the factory; and

Quality supervision report

- (e) a quality supervision report should be submitted by the RSE as required under regulation 10 of the B(A)R, prior to the application for occupation permit. The report should include a statement signed by the RSE to confirm that adequate supervision has been provided in accordance with the quality supervision plan, a copy of the inspection log book of the quality control supervisors of the RSE stream and the RC stream for the heat soak process required in paragraph 13(d)(iii) above, and a soft copy of the record of the data logger required in paragraph 13(d)(ii) above.

Structural Sealant

14. For better aesthetic appearance, structural sealant may be used in the curtain wall, window or window wall works. The proposed structural sealant should be compatible with the glazing system and the structural frame with which it is in contact. Compliance certificates comprising sealant compatibility test report, sealant adhesion test report and print review report in accordance with the Glass Code together with deglazing test report are required to be submitted prior to the application of an occupation permit or the submission of Form BA14 as appropriate. The compliance certificates and deglazing test report should be made by sealant manufacturer and be also appended with a statement signed by the RSE who has prepared the plans to confirm the acceptance criteria appropriate to the test have been complied with.

Design of Spider Fixing

15. The design of metal spider fixing as the fixing device for supporting glass panes should be verified by means of proof load test. In addition, attention should be given to its detailing at the interface connection with the glass panes, which should be designed to accommodate all anticipated movements. The mechanical properties, dimensions, load capacities and specific proprietary model number/series of metal spider fixing should be shown in the relevant plans submitted for approval.

16. Proof load test on metal spider fixing should be conducted in accordance with the test criteria specified in Appendix B upon completion of the works. The test report should be endorsed and submitted by the RSE prior to the application of an occupation permit or the submission of Form BA14 as appropriate. Proof load tests of metal spider fixing may not be required if the type of the proposed metal spider fixing is already included in the Central Data Bank promulgated in PNAP ADM-20 and uploaded to the Buildings Department (BD) website.

Locking Devices of Openable Sashes/Sub-frames

17. Locking devices are used to restrain openable sashes/sub-frames of windows, window walls and curtain walls in locked positions. All components of locking devices should be made of durable and non-combustible materials.

18. Locking devices should be evenly distributed along the sash/sub-frame to allow even load distribution on the window frame/curtain wall. The locations and the ultimate design strength of the locking points should be shown on structural plans for approval². The ultimate design strength should be the characteristic strength divided by a factor of safety (FOS) of 1.8. The characteristic strength should be verified by means of a proof load test in accordance with the test criteria set out in Appendix C and the test report should be endorsed by RSE and submitted to BD prior to the application for an occupation permit or the submission of Form BA14 as appropriate. Proof load tests of locking devices may not be required if the type of the proposed locking devices is already included in the BD's Central Data Bank.

19. In order to ensure all locking points can be triggered effectively, a single handle bar should not be connected to more than 8 locking points.

20. Hinges for openable sashes/sub-frames should be adequate in holding its own weight. In general, the size of a top-hung sash should not exceed 2.5m². Similarly, the width of a side-hung sash should not exceed 700mm.

21. AP/RSE should ensure the openable sash/sub-frame and the locking devices are properly designed and assembled to meet the performance requirements and construction tolerance. In normal circumstance, the FOS of 1.8 is considered adequate for covering construction tolerance. Improper assembly may cause additional moment on the components of the locking devices. Adequate site supervision should also be provided to ensure that the works are properly assembled.

/Safety ...

² The requirements on locking devices are applicable to all new or major revision of structural plans for development proposals or alteration and addition works submitted to the BA for approval on or after 1 August 2020.

Safety Test for Curtain Wall

22. Under regulation 43(6) of the B(C)R, a curtain wall is required to undergo a safety test. The test should be carried out by an independent laboratory accredited by the Hong Kong Laboratory Accreditation Scheme (HOKLAS) or by other laboratory accreditation bodies which have reached mutual recognition agreements/arrangements with HOKLAS. The test carried out by an accredited laboratory should be within its scope of accreditation. The test reports should be made on a HOKLAS endorsed certificate or equivalent certificate/report and be also appended with a statement signed by the RSE who has prepared the plans to confirm the acceptance criteria appropriate to the test have been complied with. They should be submitted prior to the application of an occupation permit or the submission of Form BA14 as appropriate.

23. As a curtain wall may comprise various pane sizes subject to a wide range of design wind pressure, the test panes should be selected based on engineering judgement and with justification of mathematical computation models where appropriate. It is desirable to specify the representative test panes in the curtain wall plans. Detailed requirements of the safety test are given in clause 8.3.1 of the Glass Code.

Inspection, Maintenance and Repair

24. In view of the special requirements for the design and construction of curtain wall, window and window wall, the inspection, maintenance and repair of such works shall follow Annex D of the Glass Code. The BA recommends all APs and RSEs to adopt the guidelines and requirements given in the Glass Code. They are also requested to offer help and advice as appropriate to their clients who have curtain walls, windows or window walls in their buildings.

Aluminium Windows

25. Reference may be made to PNAP APP-116 in respect of the design and installation guidelines on aluminium windows.

Concurrent Processing of Approval and Consent Applications

26. For curtain wall works, the application for approval of plans and consent to the commencement of works may be made concurrently under PNAP ADM-19.

(YU Tak-cheung)
Building Authority

Ref. : BD GP/BREG/C/6(V)

This PNAP is previously known as PNAP 106
First issue September 1984
Last revision May 2012
This revision May 2020 (AD/NB2) (General Revision)

**Standards Commonly Used for the
Design & Construction of
Curtain Wall, Window and Window Wall
Acceptable to the Building Authority**

Reference Standards

The standards listed in this appendix and PNAP APP-53 are intended to provide reference information only for the purpose of design and construction of curtain wall, window and window wall systems. It should be noted that:

- (a) the standards listed are not meant to be exhaustive;
- (b) national standards and codes of practice of various countries, though similar in major aspects, do not have exact equivalence to one another;
- (c) should a certain design standard be adopted, it should be applied to the design consistently; and
- (d) Building Regulations shall always take precedence over other design standards should there be a conflict between them.

A. Material & Workmanship

	Standard	Title/Description
Glass	Hong Kong Code of Practice	Code of Practice for Structural Use of Glass 2018
Stainless Steel	BS EN 10029:2010	Hot rolled steel plates 3 mm thick or above - Tolerances on dimensions, shape
	BS EN ISO 9445:2006	Continuously cold-rolled stainless steel. Tolerances on dimensions and form.
	BSEN ISO 9445-1: 2010	Part 1. Narrow strip and cut lengths
	BSEN ISO 9445-2:2010	Part 2. Wire strip and plate/sheet
	BS EN 10048:1997	Hot rolled narrow steel strip. Tolerances on dimensions and shape
	BS EN 10051:1991+A1:1997	Continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels. Tolerances on dimensions and shape
	BS EN 10095:1999	Heat resisting steels and nickel alloys

B. Design

	Standard	Title/Description
Glass	Hong Kong Code of Practice	Code of Practice for Structural Use of Glass 2018

C. Testing

	Standard	Title/Description
Glass	Hong Kong Code of Practice	Code of Practice for Structural Use of Glass 2018
Curtain Wall, Window, Window wall	Hong Kong Code of Practice	Code of Practice for Structural Use of Glass 2018

(Rev. 5/2020)

Proof Load Test for Spider Component

Reference Standards

The design of metal spider fixing can be verified by means of proof load test, which are required to be carried out in accordance with the test criteria specified in the Code of Practice for the Structural Use of Steel 2011.

2. The requirements and procedures for the test are:
 - (a) Sampling rate should be at least 1% or 3 numbers, whichever is more, of each representative type of the spider components concerned, and the test specimens should be set up in such a manner that is compatible with the proposed fixing details given in the approved plans;
 - (b) Test loads should be determined in accordance with clause 16.2.1.2 of the Code of Practice for the Structural Use of Steel 2011. 'Actual dead load present during the test' may be taken as the weight of the spider component. 'Remainder of dead load' may be taken as the weight of the attachment (e.g. glass panes) to the spider component;
 - (c) A test load should be applied and released in at least 5 increments and decrements respectively;
 - (d) A reading on deformation should only be taken when it has become completely stable, and readings on deformation should be taken at three 5-minute intervals at least on attainment of the test load until there is no significant increase in the deformation;
 - (e) There should be no creep for a period of at least 15 minutes under the test load;
 - (f) A running plot in respect of loading increment/decrement against deformation should indicate substantial linear behaviour under the test load; and
 - (g) On removal of the test load, the recorded residual deformation should not exceed 5% of the maximum deformation recorded.

(5/2012)

Proof Load Test for Single Locking Devices of Openable Sashes / Sub-frames

The characteristic strength of each type of single locking devices should be verified by means of proof load test. The testing specimens should fully represent the actual arrangement of the single locking devices to be installed on site.

2. The requirements and procedures for the test are:
- (a) Sampling rate should be at least 0.1% or 5 numbers, whichever is more, of each type of the locking devices concerned. The test specimens should be set up in such a manner that they are compatible with the proposed fixing details given in the approved plans;
 - (b) Test load should be applied at a constant rate; and
 - (c) The characteristic strength should be evaluated as follows:

$$\text{Characteristic strength} = \text{Average test load at failure} - K \times \sigma$$

where

K is the K-factor for at least 5 test specimens and may be taken as 3.41 (K-factor corresponding to larger numbers of test specimens may be used if appropriate); and

σ is the standard deviation.