Cladding Works

Cladding means a facing or architectural decoration additional to the external walls of a building: e.g. aluminium or metal cladding, polished granite slabs or limestone cladding, marble facing and the like. Cladding should comply with the performance requirements stipulated in Regulation 39 of the Building (Construction) Regulations in respect of material type, fixings, strength and durability.

2. Cladding shall be provided with sufficient permanently flexible joints horizontally and vertically to cater for differential movement in the cladding and in the structure to which it is attached. All external anchors, dowels and fixings should be of stainless steel or other corrosion resistant materials. Any metal dowels and fixings securing the cladding panels should be suitable, permanent and adequately protected from corrosion. For testing of anchors and cladding panels, see paragraphs 8 to 14 below.

Submission of Cladding Plans

3. Where cladding is to be affixed to any part of the exterior of a building, details such as the location and material should be shown in the general building plan submitted to the Building Authority (BA) for approval. When the cladding to be installed is above 6 metres from the adjoining ground level or adjoining floor, in addition to the building plans, details such as the thickness, strength, durability, and type of the cladding, material of fixings and sequence of support should also be shown in the structural plans submitted to the BA for approval. Failure to do so may result in delay in or refusal of approval/consent of the cladding plans. As regards the fixings of stone cladding, sand/cement bedding and/or epoxy bonding alone is not considered a suitable and permanent fixing.

4. The following details are required to be included in the structural plans for cladding for submission to the BA for approval:

(a) structural framing and details of structural elements excluding any unnecessary shop fabrication details;

(b) elevations including location of expansion joints;

(c) anchors and support details;

(d) design standards and codes of practice;

(e) material specifications for structural steel, aluminium alloy, granite/marble and anchors;

/(f) …..

(f) workmanship specifications for welding, galvanization and measures to overcome bi-metallic effects; and

(g) structural calculations comprising design check on the parent structure, analysis on the structural adequacy and stability of the proposed cladding system, element design for granite/marble, aluminium or metal cladding and deflection check on major load carrying members, if applicable.

Separate Registered Structural Engineer

5. In view of the speciality of cladding works, a separate Registered Structural Engineer (RSE) may be appointed to prepare the design and to 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 cladding 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.

6. When structural details for cladding 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.

7. The separate RSE who is appointed for the cladding 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 superstructural plans to be submitted by the project RSE to the BA for approval. The project RSE 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 cladding works and should co-ordinate with the project RSE for necessary amendment if different connection details are to be used.

Tests on Anchors and Cladding Panels

Anchors

8. On-site strength tests should be carried out on a representative number of each type and size of drilled-in anchors for those parts of the cladding to be installed above 6 metres from the adjoining ground level. Such tests are necessary to verify the performance and workmanship of the anchors installed and should be carried out under the direction of the RSE or Authorized Person (AP).

/9. …..

9. Each representative anchor should be tested by pull-out test to demonstrate that its pull-out capacity is not less than 1.5 times the recommended tensile load as specified by the anchor manufacturer. The tested anchor should be considered satisfactory if it does not show any signs of separation, plastic deformation or deleterious effect during the test.

Stone Cladding Panels

10. Stone cladding is a natural material. The mechanical properties, physical properties and chemical properties can vary considerably between different types and grades of stones. Tests on stone cladding panels are required to be carried out to verify the characteristic strengths adopted in the design and to form part of the quality assurance during construction. The RSE and Registered Contractor (RC) responsible for the cladding works should deploy a grade T3 technically competent person (TCP) under the RSE's stream and a grade T1 TCP under the RC's stream respectively on site to detect any deleterious or potentially unstable constituents such as clay-like minerals, iron minerals or veins on the stone panels delivered to site.

11. When stone cladding is to be used, the following tests are required to be carried out for each type of stone, the test results of which should be checked against the acceptance criteria given in Appendix B:

(a) flexural strength test of dimension stone to ASTM C880 – Standard Test Method for Flexural Strength of Dimension Stone or to BS EN12372 – Natural Stone Test Methods, Determination of Flexural Strength under Concentrated Load or to other appropriate equivalent standards; and

(b) strength test of individual stone anchorage to ASTM C1354 – Standard Test Method for Strength of Individual Stone Anchorages in Dimension Stone or to other appropriate equivalent standards.

12. As limestone is highly susceptible to acid rain and may deteriorate quickly when being used as exterior cladding material, in addition to the tests required in paragraph 11 above, aged strength testing to simulate weathering due to extreme temperature change and extreme moisture content change should be carried out for limestone cladding to demonstrate that the residual flexural and anchorage capacities are not less than 80% of those obtained in the standard tests specified in paragraph 11 above. The aim of aged strength testing is to simulate the conditions in which limestone panels are fully saturated and return to their driest conditions and to simulate the critical temperature changes during their intended life. For details of the aged strength test, please see section B on "Procedures for Aged Strength Tests for Limestone Panels" in Appendix B.

13. At least 5 test specimens should be selected at random from batches of stone delivered to site for each of the test specified in paragraphs 11(a), 11(b) and 12 above.

/14. …..

14. The test should be carried out by or under the direction and supervision of a testing agency independent of the supplier of the stone cladding. The test results should be certified by the testing agency, and endorsed by the AP/RSE to confirm that the test results have reached the required characteristic strengths adopted in the design. The test reports should be submitted to the BA prior to the application for occupation permit.

Design and Construction Standards

15. Standards commonly used for the design and construction of cladding works, which are acceptable to the BA, are given in Appendix A.

Minor Works Relating to Cladding

16. Under the Minor Works Control System, certain works relating to cladding in an existing building have been designated as minor works, 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 PNAP APP-147 respectively.

(AU Choi-kai)
Building Authority

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Appendix A
(PNAP APP-16)

Standards Commonly Used for the Design & Construction of Cladding Works Acceptable to the Building Authority

Reference Standards

The standards listed in this appendix are intended to provide reference information only for the purpose of design and construction of cladding works. 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

Material & Workmanship	Standard	Title
Steel	Hong Kong Code of Practice	Code of Practice for the Structural Use of Steel 2011
Aluminium	BS 1161:1977(1991)	Specification for aluminium alloy sections for structural purposes
	BS 1470:1987	Specification for wrought aluminium and aluminium alloys for general engineering purposes: plate, sheet and strip
	BS 1473:1972(2002)	Specification for wrought aluminium and aluminium alloys for general engineering purposes – rivet, bolt and screw stock

	BS 1474:1987	Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections
	BS 3571:Part 1:1985	Specification for MIG welding of aluminium and aluminium alloys
Stainless Steel	BS 8118-2:1991	Structural use of aluminium – Specification for materials, workmanship and protection
	BS 1449:Part 2:1983	Specification for stainless and heat-resisting steel plate, sheet and strip
	BS 6105:1981	Specification for corrosion-resistant stainless steel fasteners
Sealant	BS 7475:1991	Specification for fusion welding of austenitic stainless steels
	BS 6213:2000	Selection of construction sealants. Guide

B. Design and Reference

Design	Standard/Reference	Title
Steel	Hong Kong Code of Practice	Code of Practice for the Structural Use of Steel 2011
Aluminium	CP 118:1969	The structural use of aluminium
	BS 8118-1:1991	Structural use of aluminium – Code of practice for design
Natural Stone	BS 8298:1994	Code of practice for design and installation of natural stone cladding & lining
	Reference	"Guide to the Selection & Testing of Stone Panels for External Use" published by Center for Window and Cladding Technology, University of Bath (1997)

/C. Testing …..

C. Testing

Testing	Standard	Title
Sealant	BS 3712: Part 1:1991(1996) Part 2:1973(2000) Part 3:1974(2000) Part 4:1991(1996)	Building and construction sealants: Methods of test for homogeneity, relative density and penetration Methods of test for seepage, staining, shrinkage, shelf life and paintability Methods of test for application life, skinning properties and tack-free time Method of test for adhesion in peel
Anchors	BS 5080: Part 1:1993 Part 2:1986(1993)	Structural fixings in concrete and masonry: Method of test for tensile loading Method for determination of resistance to loading in shear

(10/2012)

Appendix B
(PNAP APP-16)

Stone Cladding Panels

A. Acceptance Criteria for Tests on Stone Cladding Panels

1. The tests carried out in accordance with paragraph 11 in the PNAP APP-16 are considered acceptable if the test results comply with the following requirements:

(a) the characteristic flexural strength is greater than 3 times the design allowable flexural strength;
(b) the average flexural strength is greater than the design allowable flexural strength multiplied by the Flexural Safety Factor (FSF);
(c) the characteristic anchorage strength is greater than 4.2 times the design allowable anchorage strength; and
(d) the average anchorage strength is greater than the design allowable anchorage strength multiplied by the Anchorage Safety Factor (ASF).

2. In respect of paragraph 1 above, the following applies:

(a) Characteristic strength = Average strength – $K \times \sigma$

where
K is the K-factor for at least 5 test specimens and may be taken as 3.41 (K-factor corresponding to larger nos. of test specimens may be used if appropriate); and
σ is the standard deviation.

(b) FSF and ASF may be obtained as follows:

$FSF = VF \times DF$
$ASF = FSF \times 1.4$

where VF and DF are Variation Factor and Durability Factor obtained from the tables below:

Coefficient of variance	**Variation Factor (VF)**		
	Granite	**Limestone**	**Marble**
0% - 5%	2.0	3.0	2.5
5% - 10%	2.5	3.5	3.0
10% - 20%	3.0	4.0	3.5
above 20%	3.5	4.5	4.0

Fraction of Initial Flexural Strength	**Durability Factor (DF)**
100%	1.0
95% - 75%	1.2
75% - 60%	1.5
Less than 60%	1.8

/Where …..

Where substantiation is not available, the coefficient of variance should be taken as 10% - 20%, and the fraction of initial flexural strength should be taken as (a) less than 60% for limestone and marble, and (b) 75% - 60% for granite. Accordingly, the FSF and ASF evaluated for various types of stone panels are summarized below:

	FSF	**ASF**
Granite	$3.0 \times 1.5 = 4.5$	$4.5 \times 1.4 = 6.3$
Limestone	$4.0 \times 1.8 = 7.2$	$7.2 \times 1.4 = 10.08$
Marble	$3.5 \times 1.8 = 6.3$	$6.3 \times 1.4 = 8.82$

B. Procedures for Aged Strength Tests for Limestone Panels

3. The following procedures for aged strength tests for limestone panels may be adopted on the condition that the fraction of initial flexural strength for assessment of FSF and ASF shall be taken as less than 60%:

(i) Artificial ageing of 50 thermal cycles:

Samples to be tested will be dried for 4 hours at 77°C (±2°C). The samples will be removed from the oven and cooled for 4 hours at 0°C (±2°C) in a chamber. Repeat the procedures for 50 cycles, then inspect and record the samples for any sign of damage.

(ii) Artificial ageing of 50 wet/dry cycles:

Samples to be tested will be immersed in water for 4 hours at 23°C (±2°C). The samples will be removed form the water tank and placed under forced air drying (or drying by oven) for 4 hours at 23°C (±2°C). Repeat the procedures for 50 cycles, and then inspect and record the samples for any sign of damage.

(iii) Carrying out strength testing:

Strength testing of the samples shall be carried out after completion of the artificial ageing of 50 thermal cycles and 50 wet/dry cycles to demonstrate that the residual strengths comply with the requirements specified in paragraph 12 of PNAP APP-16.

4. Alternatively, the RSE responsible for the cladding works may propose testing procedures for acceptance by the BA prior to commencement of the test.

(10/2012)