SECTION 29

ALUMINIUM ROOF PANEL SYSTEM

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GENERAL

Aluminium roof panel system

29.01 (1) Aluminium roof panel system shall comprise aluminium honeycomb panels, sealing gaskets, clamping bars, fasteners, gutters, flashings, sealants, holding-down bolts, supporting frames, barbed wires and any other accessories necessary for the proper functioning and completion of the entire system and herein specified.

(2) The design of the cover foundation and the structural steel frames was provided by the *Employer*. The location and details of the aluminium roof panel system are shown on the Drawings.

(3) The aluminium roof panel system shall be designed, supplied, and installed by a contractor with established experience in the design and erection of aluminium roof panel system similar to that stated in the Contract, to be nominated and employed by the *Contractor* and subject to the approval of the *Supervisor*.

(4) The *Contractor* shall furnish the *Supervisor* with two references relating to recent work completed by the nominated aluminium roof panel system contractor. These completed installations, together with the *Contractor*'s workshop and facilities for storage, fabrication and testing, shall be available for inspection by the *Supervisor* at all reasonable times. The *Supervisor* reserves the right to reject the nomination of any contractor whose aluminium roof panel system or workmanship is deemed unsuitable for the purpose of this contract.

(5) All details of the design, including calculations and drawings, and other documents in connection with the proposed aluminium roof panel system shall be checked by an Independent Checking Engineer. The Independent Checking Engineer shall be a professionally qualified engineer and a corporate member of Hong Kong Institution of Engineers or equivalent who has suitable experience considered acceptable by the *Supervisor*. Checking certificates signed by the Independent Checking Engineer shall be submitted to the *Supervisor* before commencement of any work for the aluminium roof panel system.

(6) The aluminium roof panel system shall be installed at the specified locations as shown on the Drawings. The *Contractor* shall note that the system details shown on these Drawings shall be regarded as essentially schematic, except for profiles of exposed surfaces which shall be as indicated.

(7) Typical fixing details of aluminium roof panel system onto the supporting frames shown on the Drawings are indicative only. The *Contractor* shall design the aluminium roof panel system and its supporting frames, associated fixings and joint details, including other necessary details not shown on the Drawings, for the approval of the *Supervisor*. For avoidance of doubt, the supporting frames for aluminium roof panel and the fixing and connections of supporting

frames to the structural steel frames shall form part of the Contractor's Design of the aluminium roof panel system.

DESIGN OF ALUMINIUM ROOF PANEL SYSTEM

Design requirements

29.02 (1) The aluminium roof panel system shall be designed to have a high level of aging and corrosion resistance to withstand the local climatic conditions specified hereunder:

(a) The atmosphere under which the aluminium roof panel system will be operating is highly humid and corrosive. The system shall therefore be tropicalized and vermin proof.

(b) The maximum and minimum operating temperature shall be taken as 44^{o}C and 0^{o}C respectively.

(2) The aluminium roof panel system shall be designed to withstand appropriate loads in accordance with the Structures Design Manual (SDM) for Highways and Railways (2013 Edition), including its subsequent amendment(s), published by the Highways Department and the relevant Eurocodes as referred to in the Manual. A peak velocity pressure of 2.8 kN/m^2 shall be assumed and appropriate pressure coefficients shall be adopted in deriving the design wind actions, with appropriate partial factors for ultimate limit state and serviceability limit state (characteristic combination).

(3) Net deflection from framing members at serviceability limit state (characteristic combination) shall not exceed 1/180 times the distance between supports or 20mm, whichever is the lesser; or 1/90 times cantilever length or 10mm, whichever is lesser. The maximum deflection of the aluminium honeycomb panels shall not exceed 0.01 times the shorter dimension of the panels or 20mm, whichever is lesser.

(4) The aluminium roof panel system shall be designed to accommodate all movements of the structures as specified on the Drawings and under a change in temperature ranging from 0^{o}C to 44^{o}C.

(5) The aluminium roof panel system shall be designed to meet the requirement that defective or damaged panels/parts can be easily dismantled and replaced without causing damage to other parts of the roof panel system.

(6) All fixings, bolts, screws etc. shall be adequate to transmit all dead, imposed and wind loadings and shall be corrosion resistant for the life of the system.

(7) The aluminium roof panel system shall be designed to provide electrical continuity between all metallic components and for electrical earth bonding.

(8) The extent and general requirements of the aluminium roof panel system are shown on the Drawings. The aluminium roof panel system details shown on these Drawings shall be regarded as essentially

schematic, except for profiles of exposed surfaces which shall be as indicated.

(9) The aluminium roof panel system shall be compatible with the steel frame structure shown on Drawings. Adequate allowance shall be provided for the potential movement of the structure as well as the aluminium roof panel system itself, particularly at the movement joints, without affecting the integrity and water tightness of the whole system.

(10) The aluminium roof panels shall be supplied with dimensions to suit the framing arrangement as specified on the Drawings. Unless specially agreed by the *Supervisor*, alternative panel sizes requiring changes in the framing arrangement shall not be allowed.

General requirements 29.03 (1) The *Contractor* shall not use any materials, equipment or practices that may adversely affect the function, appearance and durability of the completed aluminium roof panel system and related construction. The work shall be accomplished without buckling, opening of weeps, leakage, noises, or other harmful effects.

(2) All materials shall be matched to produce continuity of line, texture and colour.

(3) All work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled labour. All work shall be accomplished to the satisfaction of the *Supervisor*.

(4) To the fullest extent practicable, fabrication and assembly shall be executed in the workshop.

(5) All components exposed in the finished work shall be free from warping, oil-canning effects, and the telegraphing of welds, studs and other fasteners.

(6) Materials, components and systems incorporated in the work shall be used in compliance with the standards and procedures of the appropriate manufacturers.

(7) All fastening jointing and splicing of members shall be concealed. Exposed fasteners shall occur where expressly permitted by the *Supervisor*. Where exposed in finished surfaces, screw heads shall be Philips oval-head counter-sunk type, finished to match adjacent surfaces and evenly and neatly located in approved manner.

(8) Visible joints shall be as shown on the Drawings.

(9) All components shall be assembled, secured, anchored, reinforced, sealed and made watertight in a manner not restricting movements of the structures. All parts shall be secured by concealed means unless otherwise permitted by the *Supervisor*. Where exposed to view, screws positions shall be approved by the *Supervisor*.

(10) Sealants shall be concealed unless permitted by the *Supervisor*.

(11) Free and noiseless movement of all components of cladding and ceiling systems due to thermal, structural, wind pressure, or dead loads, shall be achieved without buckling of any component and without excessive stress to any members or assemblies.

(12) The complete aluminium roof panel system shall be designed, fabricated, assembled and installed so that all leakage and condensation shall be drained and discharged to the exterior face of the roof panels and all internal parts and spaces vented by acceptable means to ensure air pressure equalization where possible.

(13) Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water, and to minimize the potential for algae and fungus growth as a result of standing or trapped water.

(14) Weep holes vents, and drain holes shall be inconspicuously located and in such positions as not to contribute to staining, streaking or marking on the spandrels or columns.

(15) Fixing devices shall be fabricated from aluminium, hot dipped galvanized steel or stainless steel.

(16) All steelworks of aluminium roof panel system shall comply with Specification in Section 18.

(17) All steelworks of the roofing system shall be hot-dip galvanized to BS EN ISO 1461 or equivalent.

Aluminium honeycomb panels 29.04 (1) The aluminium honeycomb panel shall be of a proprietary product. Aluminium honeycomb panel shall be composite panels comprising an aluminium honeycomb core sandwiched between two skins of aluminium sheets. The minimum thickness of the aluminium honeycomb panels shall be 25 mm, and the minimum thickness of the each aluminium skin shall be 1 mm. The total thickness of aluminium honeycomb panel system shall not exceed 40 mm.

(2) The aluminium honeycomb panels and its coatings shall be suitable for using in Hong Kong climate without excessive deterioration or damage.

(3) The aluminium honeycomb panels shall possess minimum five years of application history in weathering conditions similar to Hong Kong climate, and the supplier shall produce documentary evidence for any constructing/completed works on highways or similar works involving the use of the proposed aluminium honeycomb panels in Hong Kong in the past 15 years.

(4) The aluminium honeycomb panels, its aluminium honeycomb core and aluminium sheets shall comply with the local or international legislation, codes, standards and memoranda mentioned in the manufacturer's literature and technical specification of the aluminium honeycomb panels.

(5) The *Contractor* shall propose tests and submit test reports to demonstrate the proposed honeycomb panel can meet the relevant requirements mentioned in Clause 29.04(4) and design requirements mentioned in Clause 29.02. The tests shall include but not limited to the tests on the design parameters, such as the tensile strength, modulus of elasticity, flexural strength and impact strength of the aluminium honeycomb panels, necessary for the completion of the design of the proposed aluminium roof panel system.

(6) The aluminium honeycomb panel shall be factory pre-finished by the manufacturer with PVDF (Fluorocarbon) coating applied through a "Reverse Roller Coating" process or other approved process producing comparable finishing quality. Total dry-film thickness of the coating shall be 55 microns minimum consisting of a chromate conversation coating, an inhibitive primer and a clear UV-absorbing top coat. The coated surface shall comply strictly with the "Specification for coated coil for exterior building applications" issued by ECCA (European Coil Coating Association) to achieve The Quality Label Category 1. The finished surface shall be factory protected with a self-adhesive peel off foil, tested to withstand at least 6 months exposure to local weather condition without losing the original peel off characteristics or causing stains or other damages.

(7) The *Contractor* shall allow opening in the aluminium honeycomb panels at the required locations as instructed by the *Supervisor*. The *Contractor* shall submit details of the design, including calculations and drawings to the *Supervisor* for approval before making the openings. The methods to have the openings in aluminium honeycomb panels shall be approved by the *Supervisor*.

(8) All exposed edges and corners of the aluminium honeycomb panels shall be formed by a smooth aluminium sheet of the thickness specified and shall be finished with the same type of coating as the aluminium roof panel system. Exposed sandwich core or cut edges of aluminium sheets will not be accepted.

(9) Joints between aluminium roof panels shall be applied with "G.E. Silpurf" or "Dow Corning 795" sealants or similar equivalent. The *Contractor* shall submit detailed joint layout to the *Supervisor* for approval.

(10) All coatings, when cured, shall be visibly free of flowliness, streaks sags, blisters or other surface imperfections.

(11) All finishes shall match in gloss, and fall within the colour range of the approved samples.

Anchorage system and supporting frame 29.05 (1) The aluminium honeycomb panels shall be fixed with fasteners and supporting frames to the steel structures. Welding to the steel structures shall be prohibited unless otherwise approved by the *Supervisor*.

(2) Assembly fasteners shall be stainless steel of Grade A4-80 to BS EN ISO 3506.

(3) Supporting frame shall be hot-dip galvanized steel.

(4) Where applicable, aluminium sub-frame and clamping bars shall be of aluminium alloy 6063-T6 to BS EN 573, BS EN 755 and BS EN 12020. The exposed surface shall be factory pre-finished with approved fluorocarbon coating system.

(5) Lock washer or other locking device shall be provided at all bolted connection.

(6) The *Contractor* shall construct the aluminium roof panel system in strict accordance with the approved shop drawings. Should any deviations from the shop drawings be required, the *Contractor* shall notify the *Supervisor* immediately. No work shall be carried out until further approval of these deviations has been given by the *Supervisor*.

(7) Where dissimilar metals are in contact with each other, all dissimilar metals shall be isolated with a membrane of PVC or other materials approved by the *Supervisor*.

Gutter 29.06 (1) Unless otherwise specified, all gutters shall be made of hot-dip galvanized mild steel with the minimum thickness of 3mm. Construction joints shall be made up with sleeve of the same material and thickness, mechanically fixed to the underside of the gutter, with a lap joint filled with silicone sealant of 150mm in length on each end, or continuously butt welded.

(2) All gutters shall be insulated with 60kg/m³ material wool with sufficient fall and shall be designed to withhold the rainwater in case of blockage to the drain point without failure in terms of structural and water-resistance.

(3) On-site flood test shall be carried out for all installed metal gutters. With the drainage blocked and the gutter fully flooded and covered for a period of no less than 24 hours, no seepage to the under-side shall be acceptable. Penetrations by fasteners or alike to the gutter below the flood line shall not be acceptable.

SUBMISSIONS

Particulars of aluminium roof panel system 29.07 (1) The following particulars of the proposed aluminium roof panel system shall be submitted to the *Supervisor* for approval at least four months before commencement of the roof panel works:

(a) Full details of all components of the aluminium roof panel system and inter-related fixing details.

(b) Two copies of the detailed design calculations and drawings together with the Independent Checking Engineer's check certificate demonstrating the adequacy of all components of the aluminium roof panel system.

(c) Drawings showing the plan, sections and elevations of the aluminium roof panel system at a scale of not less than 1:100.

Exact location of joints and spacing of panels together with other related details shall be clearly indicated.

(d) Drawings showing all details necessary for installation of the complete aluminium roof panel system, which shall include the supporting frame and fixing details.

(e) Manufacturer's literature and a certificate for aluminium roof panel showing the manufacturer's name, the date and place of manufacture and showing that the panels comply with the requirements stated in the Contract.

(f) Method of installation.

(g) Results of the tests referred in Clause 29.04(5) to the satisfaction of the Supervisor. All of the tests shall be carried out in accordance with internationally recognized standards and at an accredited testing institute on materials identical to those to be used. Such tests shall have been carried out not more than 36 months, before the time of submitting the roof panel system proposal.

(h) Programme of manufacture, testing and delivery, including name and address of testing institute.

(2) The *Contractor* shall ensure that sufficient time is allowed for the submission and approval of his proposal and for the manufacture and delivery of materials to avoid any delay in the roof panel works.

(3) The *Contractor* shall supply the *Supervisor* with two samples for aluminium roof panels, each of at least 0.5 m^2, together fixings and sealant for approval of their finish, colour and quality at least 30 days before commencement of the aluminium roof panel system works. Once approved by the *Supervisor*, these samples shall be retained as the standard of workmanship for manufacture of the roof panels.

(4) The *Contractor* shall provide a full size mock up sample of the aluminium roof panel system including fixing components. The mock up sample shall be at least 3 bays long and in full width or as directed by the *Supervisor*, and identical to the permanent roof panel system to be installed. The mock up sample shall be used to demonstrate the *Contractor*'s proposal and workmanship. Location of the mock up sample shall be agreed with the *Supervisor*. The mock up sample shall not be incorporated into the permanent works unless otherwise agreed by the *Supervisor*.

(5) As-constructed drawings indicating all information and details of the complete construction of the aluminium roof panel system shall be submitted to the *Supervisor* within 30 days of completion of the roof panel system works. The as-constructed drawings shall include:

- four sets of prints;
- two sets of 35mm drawing microfilming (silver) with image mounted on lower right hand side of a 186x83mm microfilm

aperture card and with details such as project title, drawing number and title, etc. typed on the aperture card for reference and indexing purposes; and

- two sets of digital data files in Microstation (.dgn) and Acrobat (.pdf) formats respectively, in the form of CD-ROM.

(6) Upon completion of the works for the aluminium roof panel system, the *Contractor* shall submit to the *Supervisor* a completion certificate signed by the Independent Checking Engineer certifying that the system has been constructed according to the approved design and drawings.

(7) The *Contractor* shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars submitted by him, whether or not such drawings and particulars have been approved by the *Supervisor*, provided that such discrepancies, errors, or omissions are not due to inaccurate information or particulars furnished in writing to the *Contractor* by the *Supervisor*. Approval of any calculations, drawings or method of installation by the *Supervisor* shall not relieve the *Contractor* of any of his obligations under the Contract.

(8) The colour reference of the aluminium roof panels shown in the Drawing is subject to confirmation by the *Supervisor*. The colour reference shall be confirmed by the *Supervisor* as part of the approval of the sample panels and the *Contractor* shall obtain the confirmation prior to placing his order.

Deviations from approved drawings 29.08 The *Contractor* shall inform the *Supervisor* of any proposal to deviate from the approved drawings and submit revised drawings for approval. The *Contractor* shall not proceed with any works affected by such revision until approval is received.

Warranty 29.09 The *Contractor* shall submit a warranty in the joint name of the aluminium roof panel system contractor that the works shall comply with the Drawings and Specification, free from defective materials and workmanship, materials loss of mechanical properties, structural failure, non-uniformity of surfaces, deterioration of finish, corrosion and distortion, etc. for a period of ten years from the date of completion of the Works. The warranty shall be submitted upon completion of the Works in the form to be accepted by the *Supervisor*.

Maintenance manual 29.10 The *Contractor* shall produce a maintenance manual for the completed aluminium roof panel system and submit 4 copies to the *Supervisor* upon completion of the Works. The manual should be developed in parallel with the design and shall include, but not be limited to, the following information:

(a) Name, address and telephone number of each firm and/or sub-contractor involved in the supply of materials, components, assemblies and finishes.

(b) A clear and concise description of the construction used to form the various areas of aluminium roof panel system of the project.

(c) Loading assumed in the design.

(d) Copies of materials, components and finishes certifications and test reports as required by this Specification;

(e) A method statement covering the procedures for replacement of damaged or otherwise defective materials or components, and materials and components which have a design life less than that of the aluminium roof panel and will therefore require replacement during the life of the aluminium roof panel system.

(f) Recommendations for routine maintenance, cleaning, suitable cleaning agents and any lubrication/adjustments to working parts.

(g) A full set of construction drawings, updated to include any changes made up to the time of completion of the aluminium roof panel system.

(h) The terms and conditions of any guarantees relating to the installed system.

INSTALLATION OF ALUMINIUM ROOF PANEL SYSTEM

Material handling

29.11 The *Contractor* shall:

(a) not damage the components when handling;

(b) leave protective wrappings and surface protection tape in place for as long as possible;

(c) transport components and store under cover, protected from weather, damage, dirt, distortion and theft;

(d) arrange storage to allow removal in sequence as required for fixing;

(e) ensure all components are marked or numbered to facilitate assembly; and

(f) ensure all materials, components and systems incorporated in the works are used in compliance with the standards and procedures of the appropriate manufacturers.

Installation of aluminium roof panel system

29.12 The *Contractor* shall:

(a) ensure that on the completed aluminium roof panels

- horizontal and vertical lines are straight and right angles are true at 90°;
- bow and twist in the framework is minimized so that the weather-tightness of the system is maintained and panels are neither stressed nor distorted;

(b) prevent any contact between different materials which may cause or promote the corrosion of either, and take effective measures to insulate any such materials which may come into close proximity with each other;

(c) protect the aluminium roof panels from damage during installation;

(d) prevent aluminium components to come into contact with cement or gypsum based products or harmful chemicals; and

(e) remove all protective tape, coating and identification numbers, on completion of the exterior of the works.

TESTING

Watertightness of aluminium roof panel system

29.13 After installation, all joints and seals shall be tested for watertightness by a water test. Sufficient water to simulate a rainfall intensity of 140mm/hr shall be pumped onto the aluminium roof panel system being tested for a minimum period of 20 minutes. Any leakage found shall be made good using techniques and materials recommended by the *Contractor* and approved by the *Supervisor*.

Deflection of aluminium roof panel system

29.14 Before installation of the roof panel system or as directed by the *Supervisor*, a load test at testing panel of approximate size 3m x 2m, or other size as agreed with the *Supervisor*, shall be carried out by the *Contractor* to demonstrate the deflection of the proposed aluminium roof panel, installed by the fixing method proposed by the *Contractor*, can meet the relevant requirements stated in Clause 29.02. The deflection of the panel and the slippage between the panel and clamping bar/ supporting frame shall be recorded.