

PRELIMINARY REPORT
ON
THE COLLAPSE OF ROOF STRUCTURE OF
CHAN TAI HO MULTI-PURPOSE HALL OF
HU FA KUANG SPORTS CENTRE OF
CITY UNIVERSITY OF HONG KONG
TAT CHEE AVENUE, KOWLOON
ON 20 MAY 2016



Buildings Department

June 2016

Introduction

1. On 20 May 2016 at about 2:30 pm, the roof structure of a multi-purpose sports hall, named Chan Tai Ho Multi-purpose Hall (the Sports Hall), in Hu Fa Kuang Sports Centre (the Sports Centre) of the City University of Hong Kong (CityU) collapsed. There was a greenery cover of shallow soil depth on the top of the roof structure. Two staff members of CityU sustained minor injuries and a third individual was in shock in the incident.

2. The Buildings Department (BD) carried out inspection immediately and did not identify any obvious structural danger in other parts of the Sports Centre. As the extensive wreckage of the collapsed roof structure was posing a safety and stability concern, and CityU was unable to arrange for temporary stabilisation works, BD engaged the government contractor to carry out necessary urgent works to ensure safety of the affected structure and the public. The temporary stabilisation works are still underway on site.

3. The purposes of BD's investigation are to assess the structural safety of the roof structure with respect to its design and construction as well as its conditions before the incident, to determine the cause(s) of the collapse and to consider follow-up actions and measures to enhance building safety.

4. This preliminary report covers the position up to 13 June 2016 regarding BD's initial findings on the surrounding circumstances and factors which BD has so far identified which require further investigation to be conducted.

5. BD is in the course of considering the Report of the Investigation Committee for the CityU Sports Hall Incident (The Redacted Version)¹ dated 6 June 2016, which was released by CityU on 10 June 2016.

¹ It is noted that CityU's said redacted report has certain parts on pages 14, 15 and 16 thereof redacted and does not include any of the appendices, exhibits or documents mentioned therein.

Methodology

6. The information stated in this preliminary report has been based on:

- (a) Site inspections and investigation;
- (b) Records kept by BD including approved building plans, drainage plans and structural plans etc. of the Sports Centre (approved plans);
- (c) Information and documents obtained from CityU including incident reports², CCTV footage, contract documents for the roof greening on campus buildings etc.;
- (d) Records of interview conducted by BD with relevant personnel involved;
- (e) Rainfall records from the Hong Kong Observatory³; and
- (f) Preliminary desktop study and computer check conducted by BD on major structural aspects of the approved design of the collapsed roof structure.

7. Further examination and testing of samples of the greenery cover and the collapsed roof structure are still being carried out.

8. Upon availability of the test results, more advanced structural analysis with computer modelling will be conducted to establish the cause(s) leading to the collapse of the roof structure and the likely failure mechanism.

² These are recent incident reports (“事件報告書”) prepared by the Campus Development and Facilities Office of CityU in response to complaints and reports in relation to the Sports Hall prior to the collapse incident on 20 May 2016.

³ Rainfall records for the period from September 2015 to May 2016.

The Subject Building

9. The Sports Centre is situated in the 6-storey Amenities and Sports Block of reinforced concrete construction. The occupation permit for the Amenities and Sports Block was issued in January 1990.

10. The Sports Hall is situated at Floor 05 of the Sports Centre with a clear headroom of about 10m (*Annex 1 - Roof Plan* and *Annex 2 - Section A-A*). The roof structure of the Sports Hall was a space truss system (STS) with its rooftop level at Floor 08 (the Roof). There is no record of submissions of alteration and addition works for the Roof after the issue of occupation permit.

11. The Roof was only accessible by a cat ladder with no protective barriers provided at the periphery. The Roof was designed to have a fall in a gradient of 1 in 80 towards two opposite sides for discharge of rainwater onto the surface channels at the adjacent reinforced concrete flat roofs at Floor 07.

12. According to the approved plans kept by BD, the overall dimensions of the STS were 42m long, 36m wide and 2.25m high. The STS was structurally constituted of a 125mm thick reinforced concrete slab supported by steel space frames comprising hot rolled rectangular hollow sections as the chords and cold formed circular hollow sections as the webs. The STS was supported on 4 sides by a series of bearings at 3m intervals. The approved design imposed load of the STS was 0.75 kPa⁴, which was the then minimum imposed load for inaccessible⁵ flat roofs. (*Annex 3 - General structural layout of the STS.*)

13. According to the information and documents obtained from CityU, a roof greening project for certain campus buildings (including the Amenities and Sports Block where the Sports Hall is situated) was carried

⁴ The design imposed load was specified in Drawing No. HKCP/101 approved by the Building Authority on 3 February 1989. The drawing can be inspected via the Building Records Access and Viewing On-line (BRAVO) system at BD's Building Information Centre or over the Internet upon application and payment of the prescribed fee.

⁵ Pursuant to Regulation 17 and Table 1 of the Building (Construction) Regulations (Cap. 123B), an inaccessible roof refers to a roof where no access is provided except such access as may be necessary for maintenance work only.

out between May 2015 and February 2016. Its scope covers, amongst others, the replacement of existing waterproofing membranes, the provision of greenery covers, the installation of an automatic irrigation system and the addition of a water tank⁶. From the documents provided by CityU, the greenery cover on the Roof of the Sports Hall comprises several layers of materials including vegetation and soil layers. No submission of building plans to BD was made in respect of the greenery cover prior to laying it on the Roof of the Sports Hall.

Site Observations

14. BD carried out site inspections to assess the extent of damage caused by the collapse of the Roof and to verify conformity of the construction of the STS with the approved design. However, detailed inspection to the collapsed STS is not possible due to the unstable condition of the wreckage. Further inspection will be made after completion of temporary stabilisation works which is still being carried out. Nevertheless, the following were noted from the cordoned off area at Floor 05:

- (a) The whole STS collapsed and fell onto the floor of the sports hall below i.e. Floor 05. A portion of the roof structure along Grid Line (GL) 29 (*Roof Portion A*) was deformed and leaning against the gallery sitting area at Floor 06, with the greenery cover slid down. The remaining portion of the STS was lying flat on Floor 05.
- (b) Majority of the guided bearings along GL 32 failed and their steel guiding plates and dowel bars were pulled out from the concrete beams. For guided bearings along GL Q, the steel guiding plates and dowel bars remained intact. For free bearings along GL 29 and GL L, the steel plates remained intact.
- (c) Inspection to part of the underside of *Roof Portion A* at Floor 05 revealed that the steel members of the STS were in fair condition

⁶ The water tank is situated on the roof of Academic 1 Building. Building plans for the water tank were approved by BD in August 2015. The respective alteration and addition works on the roof of Academic 1 Building were certified complete by an authorized person and a registered structural engineer in December 2015.

with no apparent rusting.

Collection of Samples

15. Preliminary comparison between the samples of the greenery cover taken at the scene and the documents on the roof greening project obtained from CityU has been made. Further examination and laboratory testing of the samples of the greenery cover will be carried out.

16. For the roof slab underneath the greenery cover, several cores were taken. The cores revealed different layers comprising waterproofing membrane, screeding, insulation foam and reinforced concrete, placed on top of the metal sheet decking.

17. The thickness of the reinforced concrete layer of the cores is at variance with that shown on the approved plans in BD's records. In addition, the other layers are not shown on the approved plans while the design calculations of the STS have indicated different components of the covering layers. More samples of the greenery cover and the roof slab have to be taken to verify the exact composition and extent of deviation, if any, from other related records.

Further Investigation to be Conducted

18. Having regard to the extent of the collapse of the Roof, information collected up to 13 June 2016 and the surrounding circumstances, the following factors have so far been identified as possible contributory factors to the collapse incident that warrant further investigation:

- (a) design fault of the STS;
- (b) use of substandard materials for the STS;
- (c) discrepancies in the construction of the STS and non-conformance to the original design;
- (d) poor workmanship of the STS;
- (e) overloading due to excessive building services mounted underneath the STS;

- (f) lack of maintenance of the STS;
- (g) unauthorised alteration of the STS;
- (h) overloading due to the roof slab underneath the greenery cover;
- (i) overloading due to the installation of greenery cover on the Roof;
- (j) deficient drainage system and water ponding on the Roof; and
- (k) misuse of the Roof.

Tasks Conducted

19. BD has retrieved and scrutinised the documents previously approved by BD for the Sports Centre while collection and examination of information and documents obtained from CityU, conducting of interviews, statements taking and sample taking from the scene are continuing.

20. A preliminary desktop study of the approved plans, original design assumptions, calculations, computer modelling, connection details and elements design was carried out. The preliminary desktop study and computer check on major structural aspects of the approved design of the collapse roof structure indicated no irregularities of the original design. Further review will be carried out when the sample taking from the collapsed roof is completed and the material testing results are available.

21. Samples of the greenery cover and cores of the roof slab were collected. More samples will be collected for testing. Collection of information on the construction and maintenance records of the roof structure from CityU will also be conducted.

The Greenery Cover

22. According to the information and documents provided by CityU, site observations and samples taken on site, the greenery cover was a modular green roof assemblage laid on the Roof, layer by layer, with substrate materials, soil and vegetation. According to the information from CityU and site observations, the greenery cover was resting on top of the Roof by its own weight without any fixings. Further investigation has to be made to more fully ascertain the nature and scope of the roof greening

project mentioned in paragraph 13 above. All relevant factors will be taken into consideration which include but not limited to the degree of fixation and permanence of the greenery cover, extent of the greenery cover, intended use of the greenery cover, provision of other facilities in and around the greenery cover, ease of assembling and ease of removal of the greenery cover.

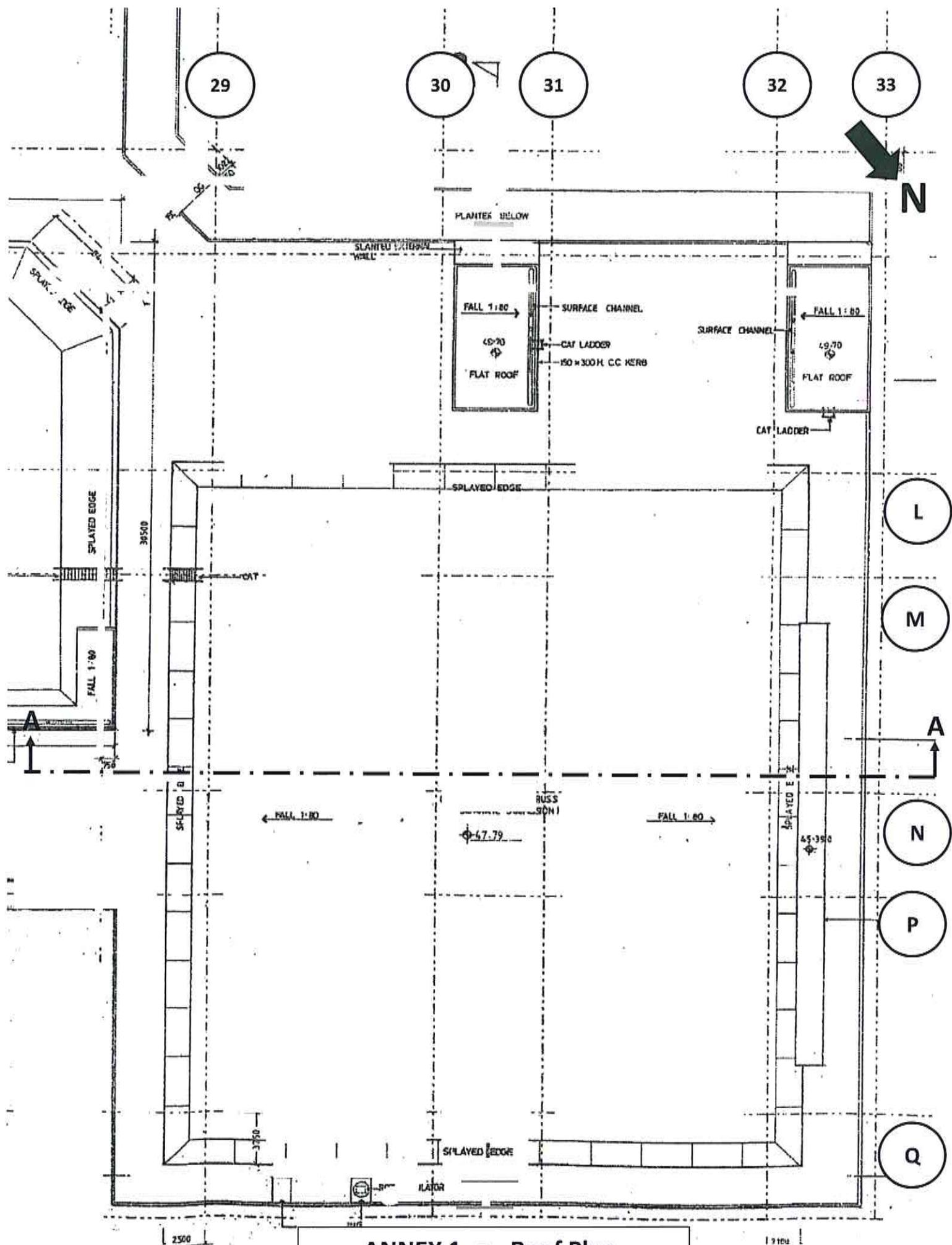
23. According to the approved plans in BD's records, the Roof at Floor 08 was designated as "Flat Roof" of inaccessible roof design⁷ with no protective barrier provided at the periphery. No specific use of the Roof has been shown on the occupation permit of the Amenities and Sports Block. Whether the laying of the greenery cover on the Roof has changed the use of the Roof will be further examined with reference to the information and documents collected so far; other information yet to be obtained and thorough analysis of the circumstances relating to the incident.

Way Forward

24. Access difficulties for inspection and sample taking at the scene are encountered in the investigation while the temporary stabilisation works are on-going. BD would continue the temporary stabilisation works and investigation including sample taking, laboratory testing of samples and materials, and detailed site verification. Detailed analysis will be conducted including computer modelling and calculations when material testing results are available.

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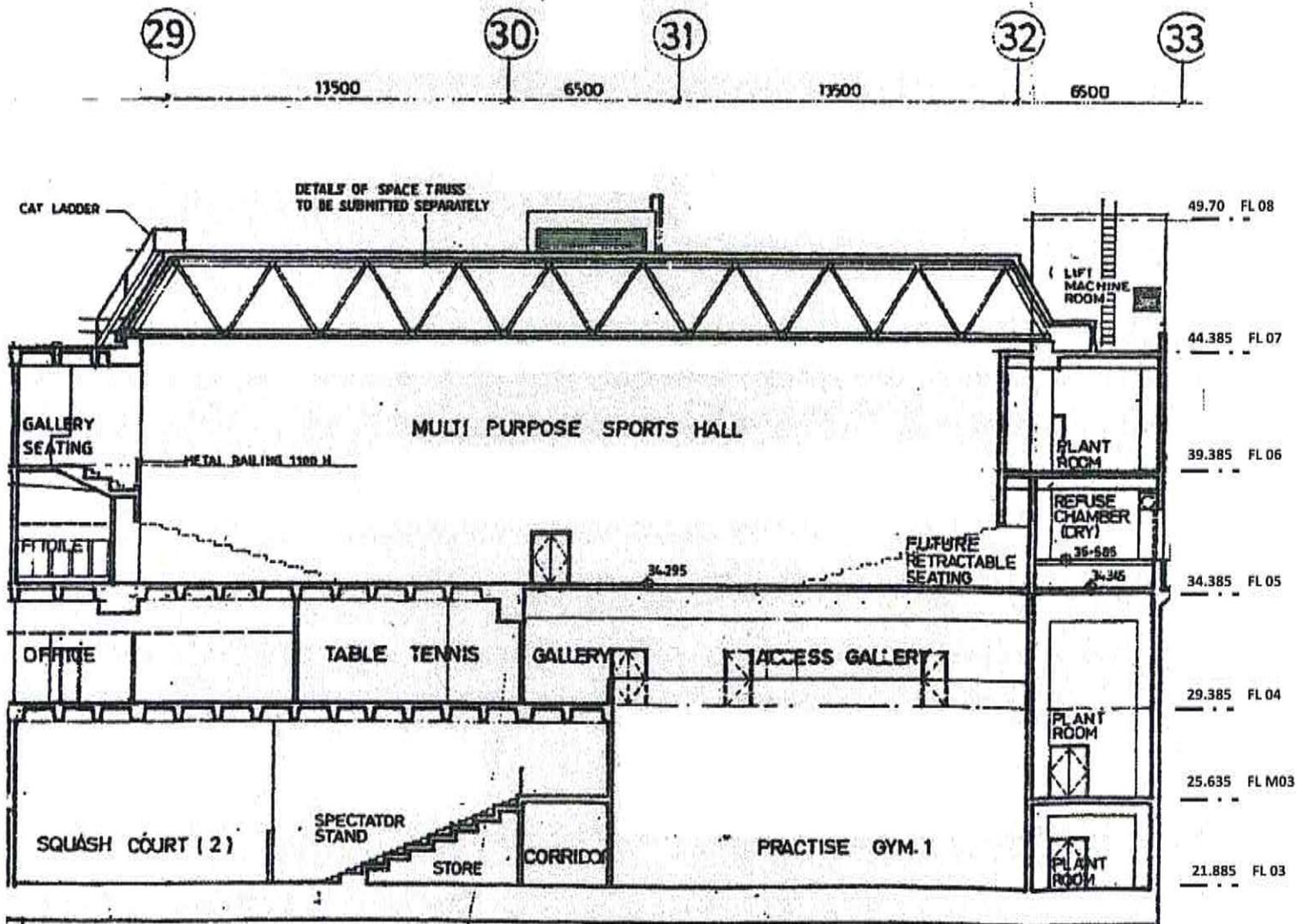
⁷ See paragraphs 10-12 above.



ANNEX 1 - Roof Plan

附件 1 - 屋頂圖則

(Floor 08 / 08樓)



ANNEX 2 - Section A - A

附件 2 - A - A 截面圖

(Hu Fa Kuang Sports Centre / 胡法光運動中心)

