POST-TENSIONED ASSOCIATION AWARDS 2018

Submission for

BEST PROJECT AWARD

Hanover Square Staircase

(Precast – PT Composite)

By

Praeter Engineering limited

Introduction

At Hanover square, an existing building was renovated with an exciting new staircase within the building. As the site was confined, many options were considered and finally decided as precast segments as the suitable solution. However these segments were required monolithic connection for stability in permanent stage. Post-tensioning was proposed to keep the segments together and adopted after careful design an

Facts about the staircase as below,

- Approximately 9m long.
- 5 PC segments were put together by PT.
- PT ducts were installed at the precast factory at preset locations. Sacrificial strands installed while concreting the precast segments to avoid damages to the ducts.
- Anchors cast within the PC units with polyforms at the ends.
- PC units were supported by temporary props at the site.
- Strands installed, stressed and then grouted to form bonded monolithic connection.

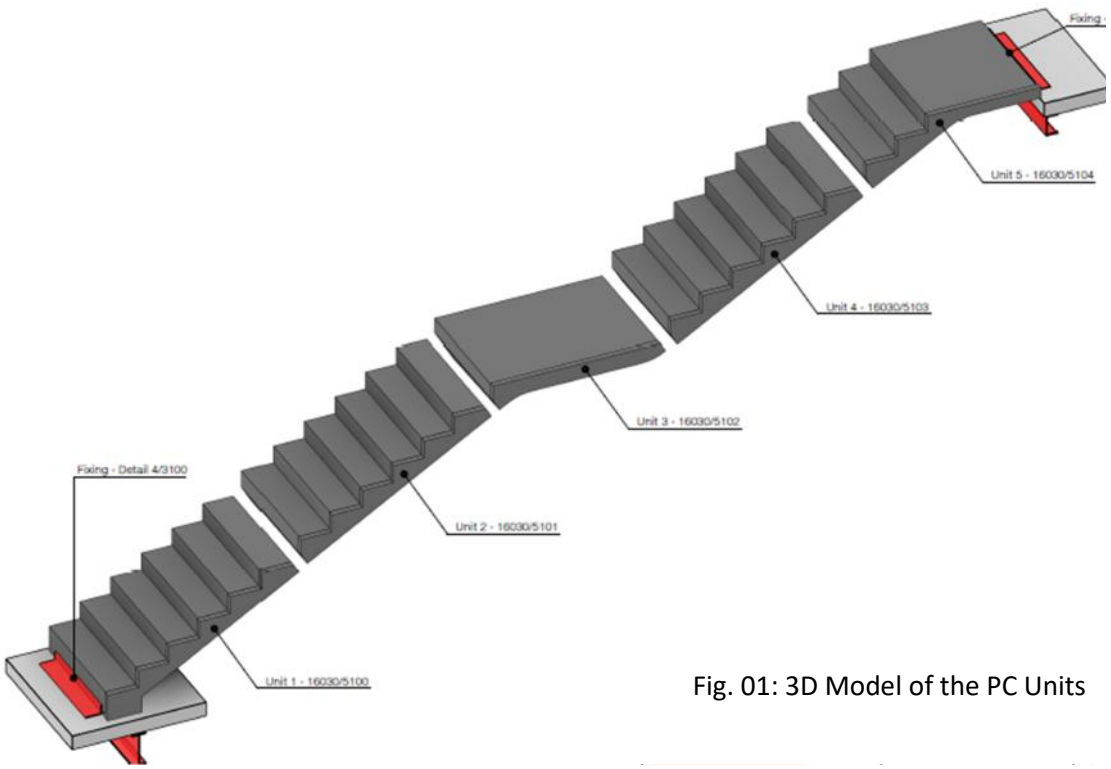
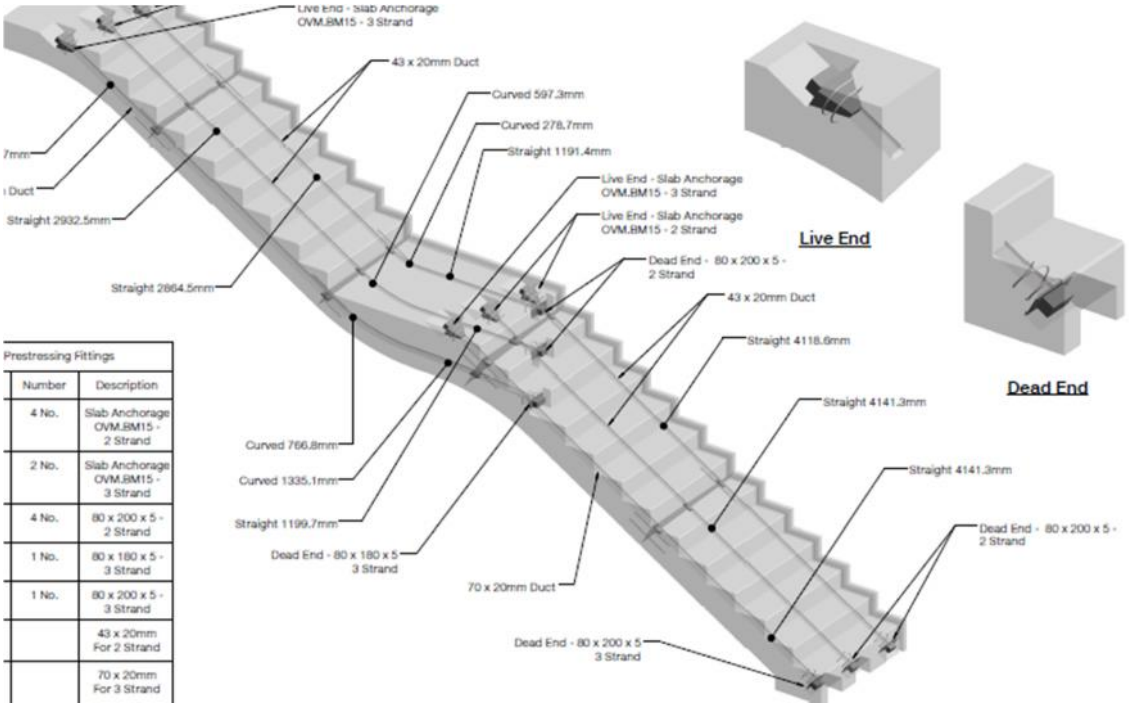


Fig. 01: 3D Model of the PC Units

Technical Process

A detailed design analysis was carried out jointly by the consultant, Pre-cast manufacturer and Praeter. The staircase will span between the 2 floors as pinned connected at the permanent stage. The segments were propped and connected by pre-set dowels during construction before stressing the tendons.



Prestressing Fittings

Number	Description
4 No.	Slab Anchorage OVM.6M15 - 2 Strand
2 No.	Slab Anchorage OVM.6M15 - 3 Strand
4 No.	80 x 200 x 5 - 2 Strand
1 No.	80 x 180 x 5 - 3 Strand
1 No.	80 x 200 x 5 - 3 Strand
	43 x 20mm For 2 Strand
	70 x 20mm For 3 Strand

Fig. 02: Tendons Layout

PT was mainly provided to control the deflection but also benefitted in carrying the self-weight and designed live loads. Tendons were split into two sets to cater the middle transition unit which has a flat surface at the top. The thickness was made larger at this middle segment to carry the highest compression due to lapped tendons (i.e. more pre-compression) and contain the uplifting force within. Reinforcement provided for ultimate state with suitable dowels between the units. Additional reinforcement at the middle segments were provided to restrain the uplifting force by the tendons.

The gaps between the units were grouted before stressing so that the joints would be under compression at all time. This enabled the stair to behave as monolithic one unit.

Support at the lower landing was designed as a roller type moving joint during construction to allow the shortening by PT force. Top of the support was designed as pinned and no lateral movement allowed.

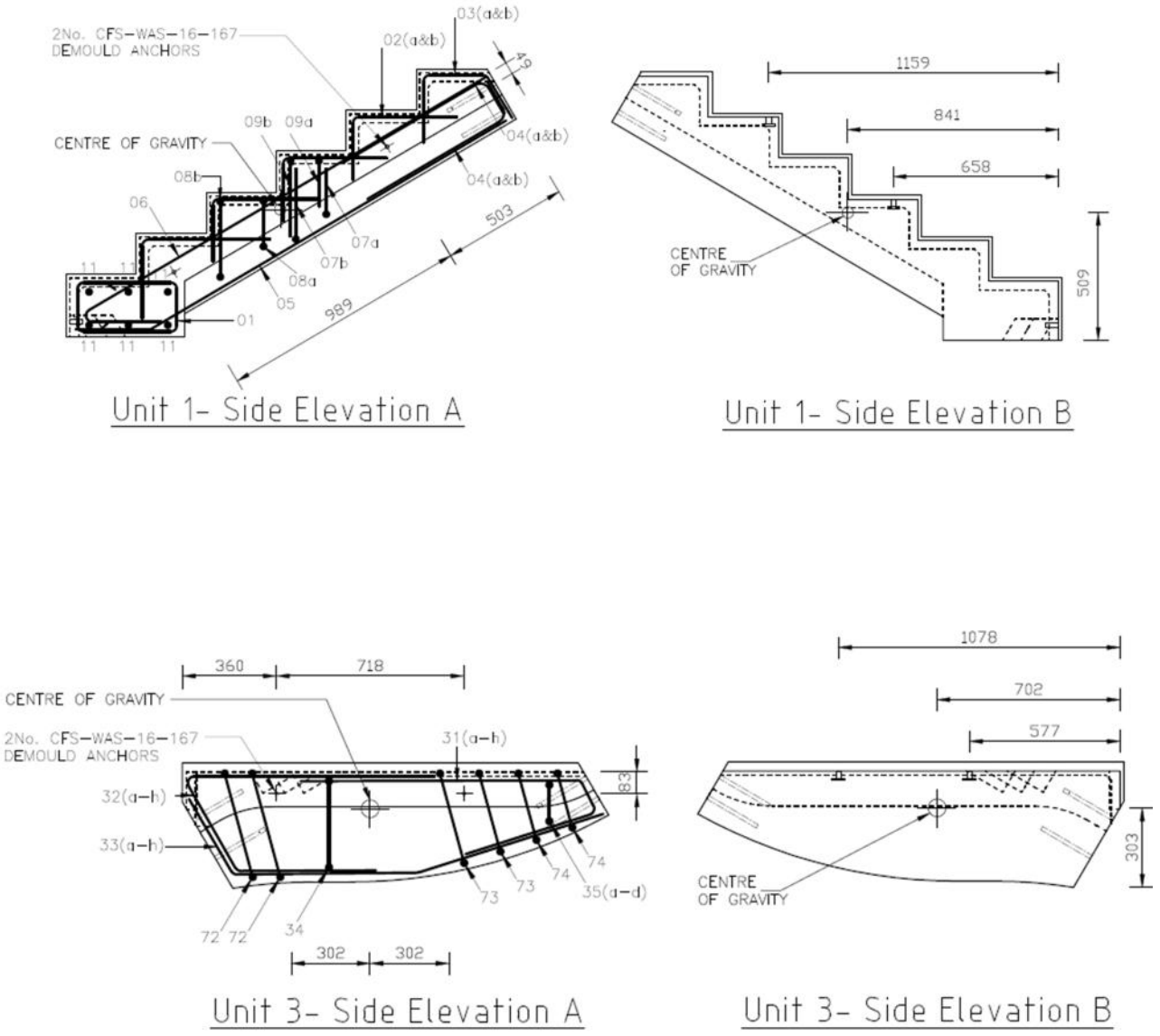


Fig. 03: Typical Reinforcement for PC units

Meeting the Judging Criteria

Judging Criteria	How well this project adopted?
Excellence in the use of Post-tensioning	Normally Post-tensioning applied within floor plates or bridges but here in a varying orientation with changing element sizes. This opens another use of PT in a built environment.
How well have the attributes of Post-tensioning been exploited	The pre-cast segments were connected by the PT so that it became a single monolithic unit once the PT force was applied. Flexible behaviour of the strands allowed the installation of tendons to follow the asymmetric stair orientations. Pre-compression and uplift of PT enabled the stair to behave within the stated deflection limits.
Innovation	• It is away from the traditional way of building the staircases. It combines the pre-cast and in-situ stitching with PT – a non-standard approach. • Long staircase without any intermediate supports. • Flat flight at the middle of the stair which required overlapping tendons with careful design. • Erected and completed within short span of time where restrictions in place for deliveries and within a confined internal building.
Sustainability	• Use of the high tensile material (Strands), i.e. only a quarter of the materials than bars. • Element thickness smaller than that of RC equivalent. • Factory manufactured and therefore minimal waste.
Value for Money	• Less materials used. • It would have been costed much more if the staircase built traditionally due to restricted access to the area and within the building. This was an already completed building and the staircase was added to improve the services. Therefore offsite manufactured small PC units were chosen with PT to perform its intended use. • Precast & PT solution was safer than in-situ as the site is confined. • Early completion and handover

Construction Photos:

Fig. 04: Tendons Stressing at the Transition Location

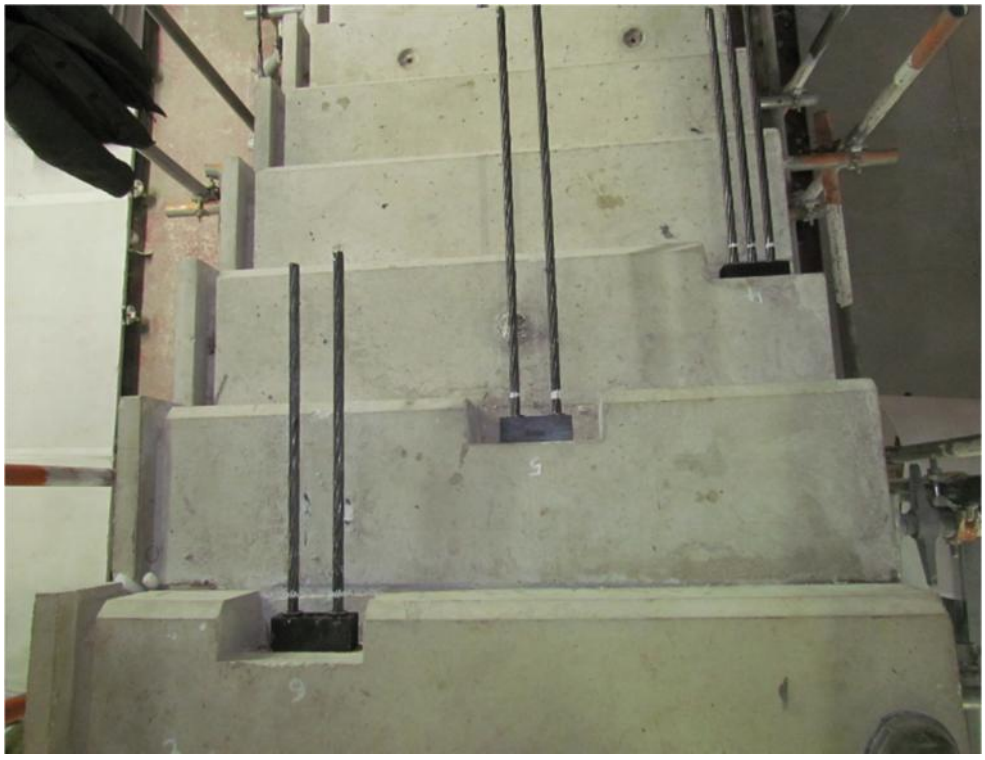


Fig. 05: Elongated Strands

Fig. 06: Gaps between the Units Were Grouted

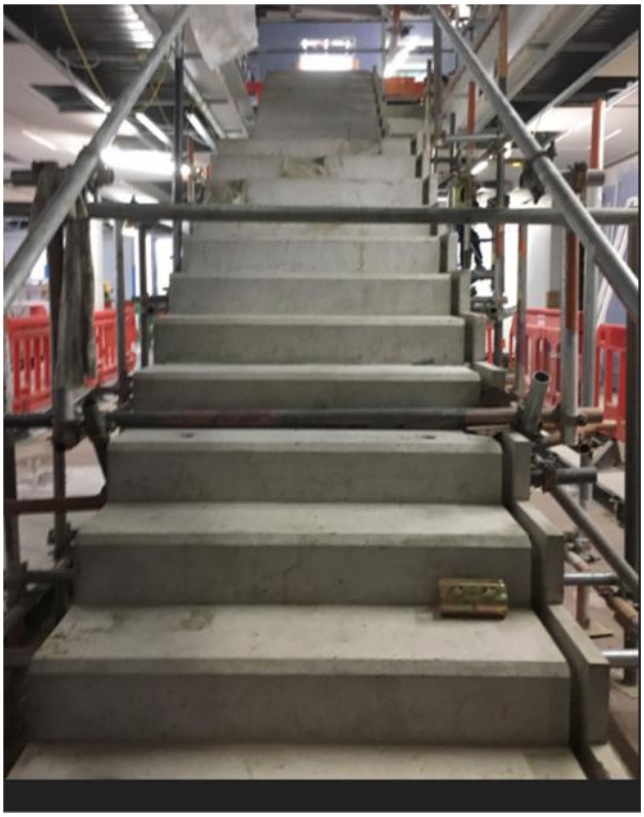


Fig. 07: After Completion of Grouting