Delivering a post-tensioned highways structure in Portsmouth

Greetham Street is a landmark project in Portsmouth for UNITE Group, a provider of purpose-built student accommodation. This 850-room project features three large post-tensioned transfer beams designed by CCL to bridge a busy roadway and support an 18-storey tower. ***Jon Machin*** *of* ***CCL*** *reports.*

At a cost of £42 million, the Greetham Street building is situated in Portsmouth city centre, within walking distance of the city's busiest university campuses and transport hubs. The accommodation is spread over a 24-, 18-, eight- and seven-storey arrangement, including a cascading central staircase from levels one to six and a highways structure traversing the busy thoroughfare of Dugald Drummond Street.

Considerations

Due to the building spanning a roadway, it is classified as a highway structure and, as such, carries an obligation to ensure an allowance for vehicle impact. This was addressed during the project's design phase of the transfer beams and bridge bearings. Situated extremely close to the Solent, buildings within the area are subjected to harsh maritime conditions. This necessitated the application of a marine-grade protective treatment to the bearings to prevent corrosion and ensure minimal maintenance over the course of their lifetime.

The 18-storey frame, which sits directly above the transfer beam, consists of reinforced concrete on short-spanning grids. A solution to prevent excess movement and maintain balance of the structure's dead loads during construction was therefore essential.

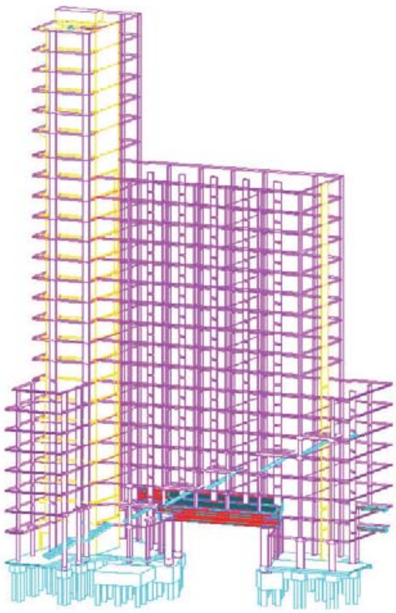
Considering the level and consistency of traffic flowing along Dugald Drummond Street, an approach that would allow continued transport access was initially sought. As such, the original plan involved the installation of precast troughs, which were to act as permanent formwork for in-situ post-tensioned beams.

However, this option proved unattainable, following an assessment of the precast trough design by CCL, which pointed to difficulties in installing the post-tensioning ducts and reinforcement within a fixed, closed precast shell. Provision of safe access for labour to install the beam reinforcement within the enclosed precast shell was highlighted under the CDM Regulations 2015, along with other key considerations for the build, such as achieving the connection between the in-situ and precast concrete.

Following successful conversations between the project's contractor and Portsmouth City Council, a closure of Dugald Drummond Street during works was granted, which eliminated a large element of risk from the project and allowed alternative solutions to be sought.

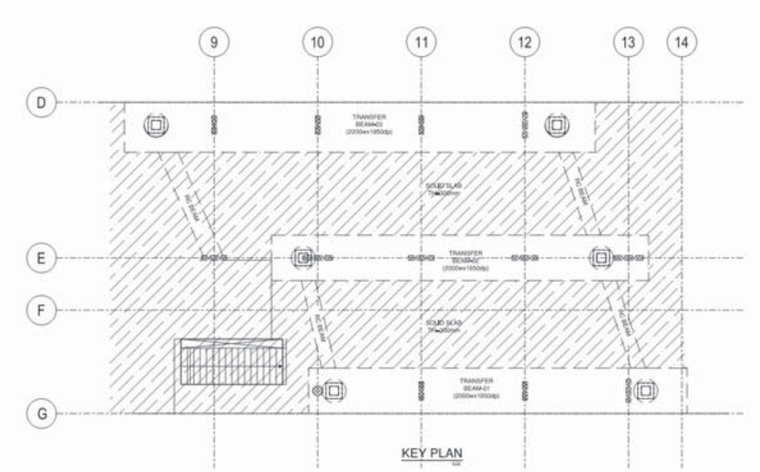
Changes to topographical survey information of the road below, made available during design stage, called for an additional 100mm reduction in transfer-beam depth in order to meet planning and highways height regulations.

A fully in-situ installation was proposed, which negated the need to use costly precast shells and carry out works across a busy carriageway. This fully in-situ approach allowed tendon drape to be exploited to a



Isometric image, showing transfer beams and RC frame.

RC frame and short-spanning grids above transfer beams.



Key plan showing placement of transfer beams.

Structural bearings supporting transfer beams.

Temporary void created for access during stressing.

Mobile crane and CCL's MG 7500 stressing jack.

greater degree, enabling a reduction in beam depth that complied with planning and highways height restrictions.

Installation

In total, three transfer beams measuring up to approximately 20m each were required to cross the carriageway, with the CCL bonded XM 37-strand, 15.7 tendon system (fully encapsulated to provide comprehensive corrosion protection) used to apply the prestress force.

Beams were stage-stressed throughout construction of the 18-storey section, in order to prevent excessive deflection and balance the dead loads of the structure. A breakdown of the stage-stressing is as follows:

- Beams and slab were poured at level two. Once the concrete had achieved 40N, 34% of stressing force was then applied across all tendons.
- Levels three to six (inclusive) were then built above this.
- Once the concrete strength had achieved 60N, the tendons were then stressed to 67% capacity.
- Levels seven to 12 (inclusive) were then built.
- A final stressing of the beams took place, achieving 100% of the total jacking force.
- Construction then continued to level 18.

It should be noted that each tendon received a massive 8251kN of force when stressed to 100% capacity.

Given the size of the transfer beams and the combined horizontal and vertical loads, CCL designed and supplied bearings with a capacity of 18,400kN to support the high loading, horizontal movements and structural rotations of the tower and transfer beams.

It was necessary to establish a temporary void in the slab at the end of each beam in order to gain access for stressing. A mobile crane was moved into position with a CCL MG 7500 stressing jack – weighing 1000kg – attached. Once the stressing operations were completed, the crane and jack were removed and the voids filled.

Goals

Fulfilled successfully, the priorities of this build were: to limit deflection and construction movements to acceptable levels; deliver a robust, yet simplified and efficient build; factor in vehicle impact, maritime climate and corrosion levels; and provision of a knowledgeable design and site team using high-quality products.

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Deflection control was achieved efficiently and effectively thanks to the staged application of force, designed to control beam movement both during and post construction.

Installation access was greatly improved, presenting an undoubted reduction in risk and complications during construction, while the fully in-situ approach, combined with a staged post-tensioning solution, resulted in a number of important improvements and enhancements to the original design work. ■