# CMP COURSE JUNE 2022

## Project

## ENGLEMERE REHABILITATION CENTRE


## Construction Technology

Construction Technology - Question 1 A), B) & C)

As the Design Manager, prepare an illustrated technical report for the Project Manager, that describes and evaluates viable options and their preferred solutions for the following aspects of the development:

A) The construction of the Core House superstructures including the transmission of imposed loads to a suitable substructure.

B) Provision of an active and passive fire engineering solution for the development.

C) Opportunities for the incorporation of prefabrication and off-site construction for the Move-On Flats.

**Contents**

## 1.0 Introduction

The purpose of this report is to describe and evaluate the viable options for the Project Manager for the proposed superstructure to be constructed to the Core House. The transmission of imposed loads and the selection of a suitable substructure will also be discussed.

## 2.0 Superstructure Frames

The four main options for the superstructure are in-situ concrete, precast concrete, steel frame, and blockwork construction. They all have their own various advantages and disadvantages, and these are set out below.

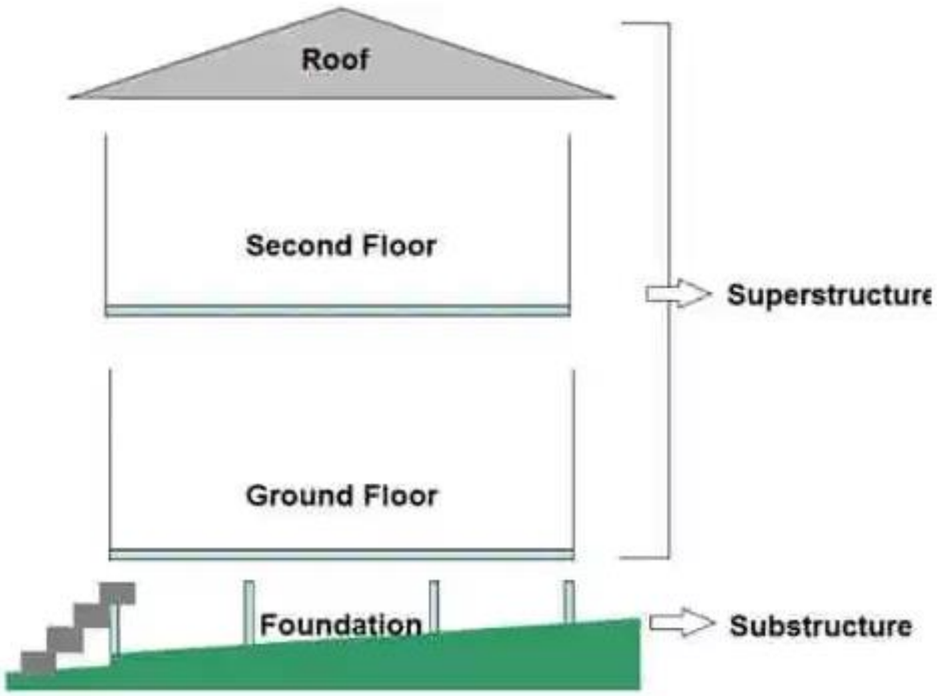


*Figure 1 – Substructure and superstructure*

## In-situ reinforced concrete and precast concrete

In-situ concrete may offer more "on-site" flexibility than precast. However, quality assurance is better controlled under factory conditions for precast units. Another advantage of precast concrete units is that they are quicker to erect as they do not require formwork.

*Figure 2 – In-situ concrete frame*

Precast units may be used as working platforms. Both systems offer good strength and fire resistance qualities. Precast beams may require suspended ceilings to allow services underneath, this can lead to reduced floor to ceiling heights. Reinforced concrete units are heavier than other systems which is normally reflected in the foundation design.

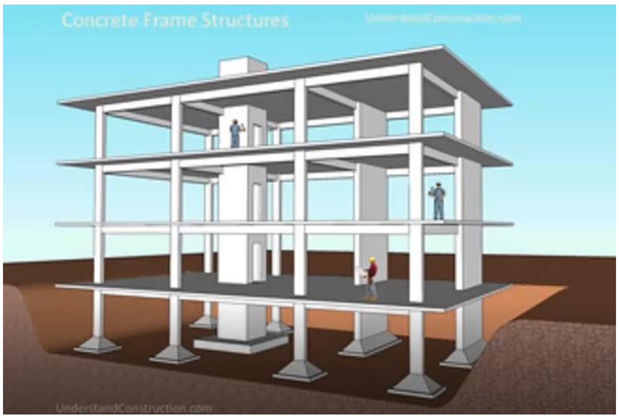


*Figure 3 – Precast concrete frame*

Steel frame

The main advantage of steel frames is the speed of erection. Structural steel beams can be cellular which allows services to pass through eliminating deep ceiling voids. The production of steel has a lower carbon footprint than concrete. However, structural steel must be protected against the effects of fire and corrosion which carries a cost.

*Figure 4 – Steel frame*

Masonry

Masonry is a versatile, traditional form of construction for internal and external supporting and non-supporting walls that is very durable and has good compressive strength. Blockwork offers good fire, acoustic, and thermal insulation qualities.

*Figure 5 – Concrete blockwork*

### 3.0 Superstructure - Floors

There are a number of options available for the construction of the floor structures which include metal deck, precast concrete, precast plank (plate flooring), and in-situ concrete. We describe and evaluate these options below.

Metal deck construction

Profiled steel decking is shot fired to the top flange of the steelwork with shear bolt fixings incorporated to provide lateral stability with the in-situ concrete floor. The total depth of the floor is normally 130 – 170mm.

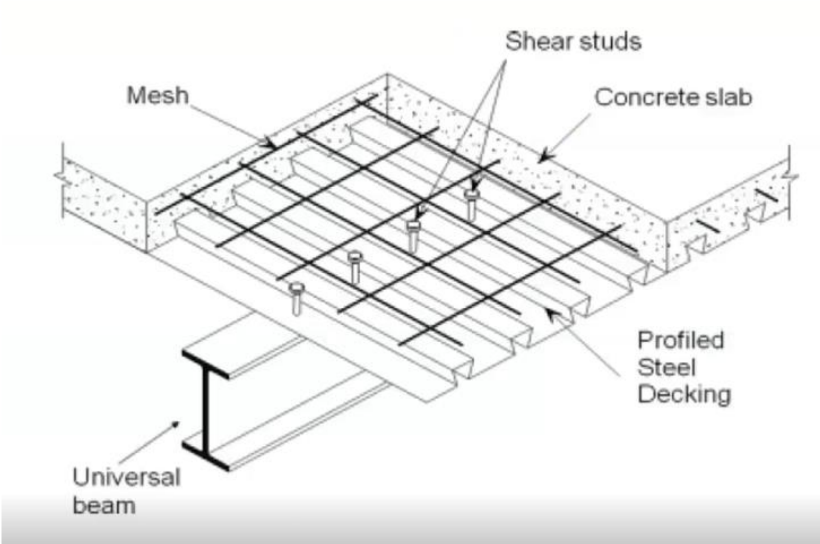


*Figure 6 – Metal deck construction*

This metal deck is reasonably quick to install but time must be allowed for the screed to be cast and cured.

Precast concrete floor construction

Precast concrete floors can be of solid or hollow core construction. These provide an instant solid working platform. The floors are quick to erect and have good fire and acoustic qualities. A concrete screed with a light steel mesh is laid over the floor units to provide the finished floor.

*Figure 7 – Precast concrete floor*

Holes for services must be pre-formed as drilling core holes on-site could cause failure to the prestressed steel bars.

<u>Precast composite plate flooring (plank flooring)</u>

This is a system where reinforced precast concrete sections with ribs are craned into place. Further steel reinforcement is fixed over the ribs and then the concrete screed is laid over providing the finished floor surface. The advantages of this method are that the thickness of floors can be slimmer than hollow-core floors. The floors may need to be propped for a period after the screed is poured. It also provides an instant working platform.

*Figure 8 – Composite plate flooring*

<u>In-situ concrete floors</u>

In-situ reinforced concrete floors are cast on formwork. There are various formwork systems, and some are quicker than others. Generally, in-situ reinforced concrete floors are slower to construct compared to others. Load cannot be applied to the floor until it has reached its designed strength and it cannot be used as a working platform until it has cured properly.

**4.0 Substructures**

The site investigations have confirmed high levels of petrochemical contamination in the made-up ground used to level the site when previous superstructures were demolished. There is a long history of coal mining in the area and some local properties have had subsidence in the past. The water table was located 0.5m below ground level.

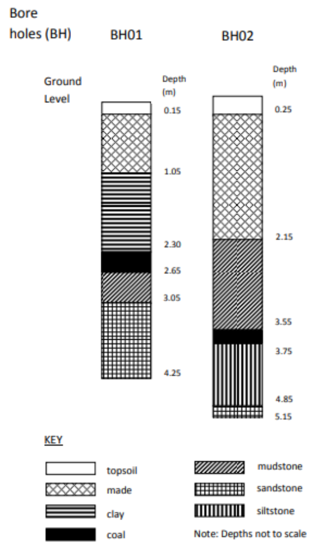


*Figure 9 – Soil investigation*

There are four main options to consider for the substructure of this building which are strip, pad, raft, and piling. The bearing capacity of the ground conditions is unsuitable for strip or pad foundations. The high-water table could put a raft foundation at risk.

**5.0 Conclusion**

As the bearing capacity of ground soils is poor, it is recommended that piled foundations should be installed which will allow the transmission of imposed loads from the superstructure to a suitable strata below ground. Given that the building is low rise, the most viable option for the superstructure would be blockwork walls constructed from the capping beam to the piles. Precast concrete hollow core floors may then bear upon the masonry walls and steel beams where required.

**6.0 Question 1 (B) – Fire Engineering**

This report sets out to outline the provisions required for active and passive fire engineering for the development. Please note that we will be using Technical Guidance Document B (TGD B) of the Building Regulations - Part B – Fire Safety - issued in the Republic of Ireland.

A copy of the floor plans for the building are attached showing the proposed fire resistance for walls and doors.

**Passive Fire Engineering**

In basic terms, passive fire engineering is associated with measures to stop or contain a fire and allow occupants time to escape or be rescued. These are outlined below.

Means of Escape

An adequate means of escape will need to be designed to allow occupants to escape from the building in case of fire to a place of safety. This includes protecting horizontal and vertical escape routes. This must include refuge areas in a place of safety for persons with disabilities to await assistance for evacuation. Travel distances and widths of escape routes must be calculated and comply with the requirements of TGD B. These will be tailored to suit the purpose group. This development is classified as purpose group 2(a) – Residential (Institutional). It is noted that there is only one means of escape provided (central staircase) and no alternative means of escape is available as would be expected and this may need to be reviewed.

Fire doors that comply with the requirements of BS 476: Part 22 will need to be installed to protect various escape routes/compartments and these will be classified with a fire resistance of 30 minutes (FD30) or 60 minutes (FD60) fire rating depending upon their location  (see attached floor plan). Some may require a smoke seal and be affixed with (S) to their description.

Smoke Control

An automatically opening vent (AOV) will be required at the top of the communal staircase to allow smoke to exit the stairwell in the event of a fire. This should be linked to the fire alarm system and open automatically in the event of a fire.

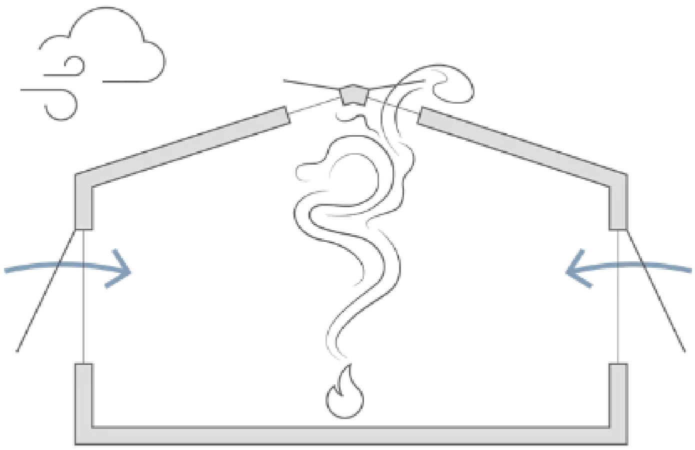

*Figure 10 – Smoke vent operation*

Internal Fire Spread (linings)

The internal linings must inhibit the spread of fire within the building. This applies to the walls, ceilings, roof lights, lighting diffusers etc. There are various classifications of performance depending upon the location of the linings and these will need to be evaluated.

## Internal fire Spread (Structure)

The building must be designed and constructed to maintain its stability for a reasonable period in the event of a fire. Structural frames, beams, columns, loadbearing walls (internal and external), floor structures and gallery structures must have the required fire resistance set out in TGD B.

## Compartmentation

The building will need to be sub-divided into compartments to restrict the spread of fire. This will involve compartment walls and floors being constructed in fire-resisting construction to the required level of fire resistance set out in TGD B. Compartment walls must be continued to the underside of the roof.

## Fire Stopping

Any penetrations for services in fire-rated construction must be adequately fire stopped by an accredited contractor.

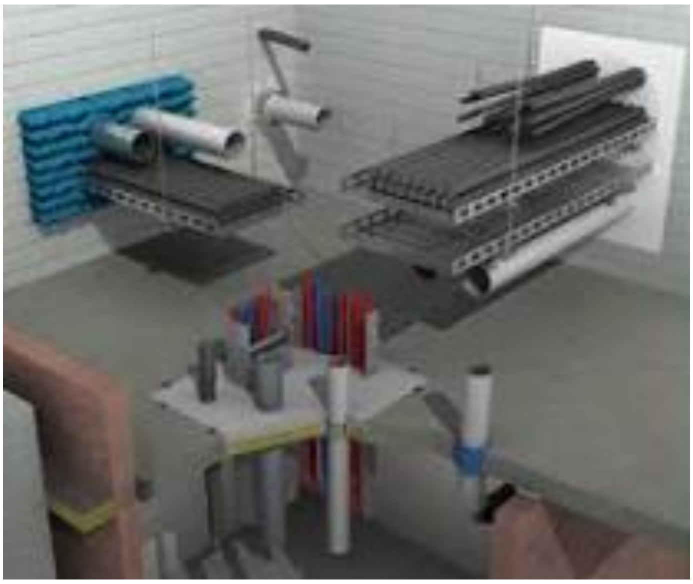

*Figure 11 – Example of fire stopping around penetration*

Concealed Spaces

Hidden voids and shafts can provide a route for the spread of smoke and flame. It may be necessary to install cavity barriers, depending upon the details of the void being considered. There does not appear to be any provision made for a service riser within the building and should this be added later, it would need to be of 60-minute fire-resistant construction.

External Fire Spread

The external walls and roof must be designed and constructed to resist the spread of fire to and from neighbouring buildings. This involves assuming a notional boundary and calculating the unprotected areas to confirm that they comply with the requirements of TGD B. We would question the suitability of the proposed timber cladding to the external walls as this would appear to provide a medium for fire spread.

Access and Facilities for Fire Service

Adequate access must be provided for fire appliances to assist the fire service in the protection of life and property. An adequate supply of water for fire services must be provided which may require the installation of a fire mains and fire hydrants.

## Active Fire Engineering

Active fire engineering provides measures to extinguish or control a fire in the building such as fire alarm systems, sprinkler systems, fire extinguishers, etc.

## Fire Alarm

The fire alarm must be designed and installed in accordance with I.S. 3218:1989, Code of practice for fire detection and alarm systems for buildings – system design, installation, and servicing. In residential (Institutional) buildings such as this, a high level of protection is required and an L1 fire detection would be required. As the building is a Rehabilitation Centre, consideration would need to be given to occupants that may be unable to self-evacuate.

## Emergency Lighting

Emergency escape lighting should be installed in locations to assist occupants to escape in the event that normal lighting installations fail. Emergency lighting should be designed and installed in accordance with I.S. 3217: 1989 Code of practice for emergency lighting.

## Suppression Systems

There are various types of fire suppression systems for different situations. The most common for this type of development would be a sprinkler system that is activated when the heat in the room reaches a certain level. Whether a sprinkler system is required or not will depend upon the layout of the flats and this will need to be confirmed in the Compliance Report that accompanies the application for a Fire Safety Certificate for the building.

## Dampers

Fire dampers would need to be installed to any ductwork to prevent the spread of smoke or fire. These are flaps within the ducts that are activated by their reaction to heat and close off the duct.

*Figure 12 – Fire damper in ductwork*

**7.0 Question 1 (C) - Prefabrication and Off-Site Construction**

There are options to prefabricate a number of elements off-site which speeds up construction and reduces storage space on site. This can also improve quality as the components are manufactured under factory-controlled conditions. Disadvantages are that the design must be finalised early in the programme to allow for manufacture and that design changes are limited once the order is placed.

Some components that could be considered for prefabrication are:

- Pile foundations and ground beams.
- Concrete staircases.
- Precast floors.
- Door sets.
- Bathroom pods.

*Figure 13 – Prefabricated bathroom pod example*


*Figure 14 – Prefabricated door set*

## 8.0 Appendices

Appendix 1 – Floor plans drawing

## 9.0 Bibliography


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