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Feasibility of Construction with Hollow-Core Concrete Slabs over R.C.C. Construction: A Case Study

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ABSTRACT:

After the formation of the new state of Chhattisgarh, several construction activities came up as a part of the Infrastructural Development Scheme. The constructions of buildings are in general done by R.C.C. But, with the need of a faster construction methods without compromising with the quality and yet keeping it less labour intensive, precast techniques have become the need of the hour. Shankaracharya Medical college building has been planned following this technology to start the building after getting approval from the competent authorities

A comparative study has been done between the conventional RCC and Steel framed Structures emphasizing the utility of pre-cast pre-stressed hollow-core concrete slabs.

INTRODUCTION:

Hollow core precast pre-stressed concrete slabs are recently being used as the floors and roofs for many multistoried structures like office buildings, residential dwellings, educational building and other commercial buildings. This method of construction reduces the overall weight of the building, increases ease in construction, provides better thermal as well as acoustic insulation properties and are highly fire resistant. One of the biggest advantages is the faster rate of construction as compared to the conventional reinforced cement concrete method.

Hollow core slabs are generally constructed using low-slump high-strength concrete and pre-stressed using high-strength pre-stressing strands (typically seven-wire strands with diameters ranging from 9 mm and 13 mm). Continuous voids are formed through each unit to reduce its weight and improve its structural performance. Hollow core slabs are typically 0.9 m to 1.25 m wide and 150 mm to 300 mm thick. The span of these slabs may reach upto 18.0 m.

CASE STUDY:

The project under study is the "Shankaracharya Medical College and Hospital Building" situated at Junwani. The project consists of a G+5 building to be used as hospital and a G+4 building for medical college.

The target was to complete the whole project within 24 months along with finishing. The total area of construction was $2.3*10^4$ sq.m for medical college and $2.7*10^4$ sq.m for the hospital building. If this was to be constructed by conventional methods, i.e., if an R.C.C structure was to be built then the estimated time required would be 36 months. Due to the time limitation it was decided to construct a steel framed structure along with pre-cast pre-stressed hollow-core concrete slabs for roofs and floors.

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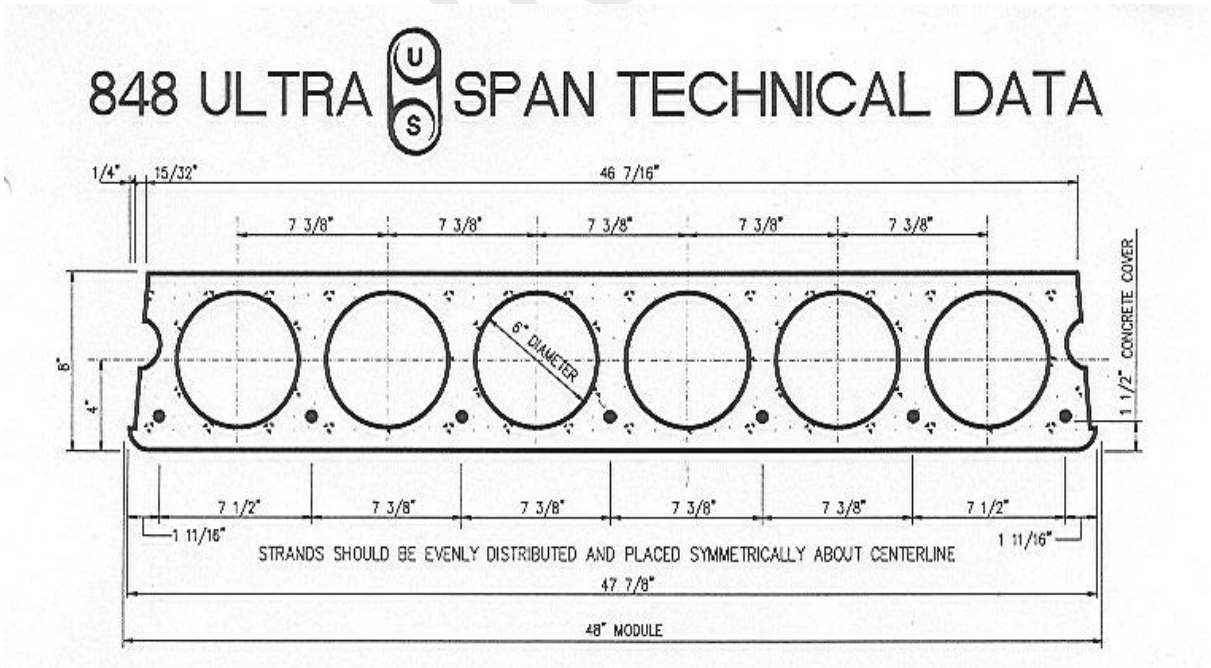
HOLLOW-CORE SLAB BATCHING PLANT

SPECIFICATIONS OF THE HOLLOW-CORE SLABS: All the slabs were 150 mm thick, 1.20 m wide, and 6.00 m long. The thickness of the slabs was taken 150 mm, the slab width 1.20 m is controlled by the available bed width used to manufacture the slabs, and the length was chosen to be 6.0 m, which is typical for the 150 mm thick slab. The concrete mix used to cast the slab was composed of 370 kg/m^3 cement (ordinary Portland cement) with a maximum water/cement ratio of 0.35. It contained 1140 kg/m^3 coarse aggregates (10 mm maximum size), 285 kg/m^3 fine aggregates (5 to 0 mm), and 500 kg/m^3 washed sand. Cubes were taken from the concrete and tested in compression at age 7 days and 28 days, which yielded concrete compression strengths of 74 and 89.5 MPa, respectively. The slabs were pre-stressed using 9 mm diameter, 1770 MPa low relaxation, seven-wire strands. The strands were placed at 30 mm from the soffit of the slab. Two additional 9 mm diameter strands were placed at 30 mm from the top fibers of the slabs to straighten the slabs.



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Pre-cast pre-stressed hollow-core concrete slabs

The common method of constructing hollow core slab is by using high strength, zero slump concrete which is reinforced by using high tensile-strength, pre-stressing wire strands of 9 mm diameter. Hollow-core slab is typically 0.9 wide and 200 mm thick. Span of slabs varied from 5m upto 18m placed simply supported over beams.

The total construction of building has been planned as 50,000 sq meter to be achieved in G+5 story. The reinforced cement concrete construction if planned with M-30 grade of concrete, 16mm diameter steel bars being used as reinforcement in column (0.9 x 0.6m), 150 mm thick R.C.C. slab used with 10mm bars. Vitrified tiles are provided as flooring over base course. The partition walls are made of concrete blocks. The finishing with putty and color wash 2 coats is considered for the purpose of estimation.

The cost of construction with these materials being used is estimated to be around Rs.12916/- sq m. Time required to complete the total construction will be around 24 months. Batching plant used for making quality concrete, steel shuttering, and mechanized procedure has been followed.

For the steel framed hollow-core precast pre-stressed concrete slab construction the procedure and materials required for the construction of foundation is the same as that of R.C.C.

Steel column bolted to foundation cap and covered with a coat of concrete

Above the foundation, steel columns were bolted to the foundation caps and were provided with a 'casing' of concrete. Further steel beams were provided to connect the columns. Hollow slabs are kept as simply supported over the beams. The top is further provided with a mesh of 10 mm diameter reinforcement bars and 50 mm thick concrete cover. Partition walls are made of concrete blocks and vitrified tiles used for flooring. As per the schedule prepared, it will take only 1 year (12 month) for the completion of the 1st phase of construction. The cost of this comes out to be Rs. 15069/- per sq.m which suggests a 14.3% increases in cost of construction.

ADVANTAGES OF PRE-CAST PRE-STRESSED HOLLOW CORE SLABS:

1) One of the most important and highly beneficial developments in the construction industry is the pre-stressed or precast hollow core slab. It is the best solution for the current market demands related to the modern housing needs. Compared to the other alternate and traditional methods of construction, precast hollow core slabs are manufactured using highly automated hollow core machines; through environment friendly manufacturing process. They consume lesser raw material and possess higher concrete strength, are structurally efficient, have reduced thickness; and also offer the possibility for reuse and recycling.

2) There are several advantages of the precast hollow core slab or pre-stressed hollow-core slab such as: heavy weight capacity, exceptional fire resistance, lower self-weight, superior acoustic insulation and thermal properties, cost-effective construction solution, offers better designing flexibility to builders, rapid speed of erection, moderate use of raw material, highly effective for circulating fresh and warm air, requires few construction site workers, offers preformed site services etc.

3) Pre-stressed hollow-core units are the most useful elements of floor construction in multi-storey buildings and residential apartments. Hollow-core slabs provide considerable benefits to builders and house owners. They are the ideal choice for constructing floors in individual homes, both at ground level and upper level. Hollow core floors are used due to their lower cost and quick erection time.

4) Further benefits include, robust structure, requires less concrete, provision of a secure working platform, extended length without central supports, efficient span/depth ratio resulting in decreased structure heights; can be easily altered to enable heating and cooling of a building even without burning fossil fuels; can be easily changed to include electrical wiring, plumbing and sprinkler facilities within the building; factory produced based on strict quality standards and safety principles, broad array of applications; appropriate for residential, healthcare, education, industrial and commercial segments etc.

5) Pre-stressed hollow core slabs have longitudinal cores that ensure to reduce the weight of the floor. These slab units can be manufactured in various depths in order to fulfill the diverse requirements for span and loading. Precast hollow core slabs are typically 1200 mm in width and about 20 m in length. These hollow core units are commonly used in structures with larger spans or loadings that include schools, industrial units, office

buildings, sports complexes, hotels, commercial outlets, hospitals, entertainment centers, etc. Hence, precast hollow core slabs assure safe, durable and healthy constructions.

CONCLUSION:

A hollow core slab refers to a precast slab that is prepared using pre-stressed concrete. It is generally used in the construction of floors for high-rise apartments or multi-storey buildings. Precast concrete constructions are very common in low-seismic regions as they are cost-effective, quick to assemble and build; have lower self weight, use less raw material, etc. These pre-stressed slabs are widely used in many countries including India, Europe, USA and Canada; where housing structures are built using precast concrete. Hollow core concrete slab is a versatile precast element. Hardly any building materials available today offer the economy, flexibility and reliability of precast, pre-stressed concrete. The hollow core units are commonly used in structures with larger spans or loadings that include schools, industrial units, office buildings, sports complexes, hotels, commercial outlets, hospitals, entertainment centers, etc. Hence, precast hollow core slabs assure safe, durable and healthy constructions.

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