Handloom Marketing Complex at Janpath, New Delhi

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Project Name :	**Handloom Marketing Complex**
Location :	**Janpath, New Delhi**
Client :	**Ministry of Textiles [DC (H)]**
Architect :	**CPWD**
Structural Consultant :	**INSDAG**
Project Management Consultant :	**HSCL**
Software Used :	**STAAD Pro. V8i**
Steel Producers :	**Structural Steel – SAIL, JINDAL**
RCC Contractor :	**Jaycon Infrastructure Ltd.**
Steel Fabricator :	**Jaycon Infrastructure Ltd.**
Surface Protection (Painting etc) :	**Jaycon Infrastructure Ltd.**
Electrical Contractor :	**Jaycon Infrastructure Ltd.**
Plumbings & Sanitary Contractor :	**Jaycon Infrastructure Ltd.**
Date of Construction Commencement :	**22.09.2009**
Date of Project Commission :	**15.07.2012**
Construction Cost :	**Rs.42.63 Crores**
Structural Steel Requirement :	**1415 MT**

Architectural Features & Concept:

The building has been conceived to incorporate sound structural engineering principles and innovative architectural concepts thus creating a truly modern building design. Out of total effective land area 7204.47 sq.m, 4096.6 sq.m i.e. more than 50% of the open area was made available for Green area. Due to acute shortage of parking spaces in the nearby areas, two basements are considered for parking. Area earmarked for parking at first basement is 2040 sq.m and at second basement is 2356 sq.m (Covered area being 2729 sq.m and 3174 sq.m). Approximately 176 car parking provision has been created including surface parking. Above the ground 2 towers of G+3 storey has been considered for housing the offices/emporiums etc. Ground floor coverage has been kept as 1793.8 sq.m. In totality 95.64 % FAR was achieved against permissible limit of 150%. Total height of the building is restricted within 15.0 m because of its proximity (within 200 m) of Jantar Mantar, a protected monument. Column to column spacing was kept at 6.0 m to utilize the advantages of Steel–concrete composite construction. A completely glass faceted bridge was provided to connect the two towers at 1st, 2nd and 3rd floor levels.

Structural Features & Concept :

Structural Features and Concept

The structural features for this building is unique due to the fact, that the columns are concrete encased steel sections acting as composite columns and the beams are basically steel beams with the top slab playing an effective role as the compression flange of the steel-concrete composite beam.

Design Philosophy

The building has been modeled as a 3-D frame with rigid joints between the elements of the frame. The floor slabs have not been included in the 3-D model. The frame of the building was analyzed with Steel-Concrete Composite option keeping the other structural elements with RCC or steel as required achieving an optimum solution. The building has been conceived with common basement (about 84 meters x 36 meters in plan) and two separate super structures (about 30 meters x 36 meters in plan) identical and symmetrical to each other. One structurally separate corridor is provided in between these structural units as per architectural drawings.

The entire frame was analyzed using STAAD PRO 2005 software package. The frame was analyzed for different combination of worst possible loads on the structures. The ground floor and the basement floors are meant for car parking only. From 1st to 3rd floor, the planning of the building is more or less same. The ground floor is 3.9 meters high and all other floors are 3.5 meters high. The total height of the building is about 14.96 meters above ground and 6.6 meters below ground. For claddings, brick filler walls been considered.

The individual loads, Load combinations and other design stipulations have been adopted based on the following IS Codes / References:

- IS 456-2000
- SP 16-1978
- IS 800 - LSM version (new draft code)
- IS 875-1987 (Part 2 & 3)
- IS 1786
- IS 1893-2002
- IS 11384-1985
- BS 5950 (Part 1 & 3)
- Euro Code 3 (Part 1.1)
- Euro Code 4 (Part 1.1)

For the Analysis and Design of the building, the following major design parameters were considered:

- Grade of RCC: M25
- Grade of Reinforcements: Fe500 TMT
- Grade of Structural steel: F_y 250
- Loads: All loads as per relevant Indian standards

Concept of Composite Construction

With the adoption of composite construction using columns along with composite decking and composite beams it is possible to erect high rise structures in an extremely efficient manner. There is quite a vertical spread of construction activity carried out simultaneously at any one time, with numerous trades working simultaneously. For example

- One group of workers will be erecting the steel beams and columns for one or two storeys at the top of frame.
- Two or three storeys below, another group of workers will be fixing the metal decking for the floors.
- A few storeys below, another group will be concreting the floors.
- As we go down the building, another group will be tying the column reinforcing bars in cages.
- Yet another group below them will be fixing the formwork, placing the concrete into the column moulds etc.

In case of Handloom Complex Composite Decking has not been adopted due to the non-availability of extensive range of embossed profiled sheets as required for composite floor slabs.

Concept of Composite Construction in Beams

In conventional composite construction, concrete slabs rest over steel beams and are supported by them. Under load these two components act independently and a relative slip occurs at the interface if there is no connection between them. With the help of a deliberate and appropriate connection provided between the beam and the concrete slab, the slip between them can be eliminated. In this case the steel beam and the slab act as a "composite beam" and their action is similar to that of a monolithic Tee beam. Concrete is stronger in compression than in tension, and steel is susceptible to buckling in compression. By the composite action between the two, we can utilise their respective advantages to the fullest extent. Generally in steel-concrete composite beams, steel beams are integrally connected to prefabricated or cast in situ reinforced concrete slabs. There are many advantages associated with steel concrete composite construction. Some of these are listed below:

- The most effective utilisation of steel and concrete is achieved.
- Keeping the span and loading unaltered; a more economical steel section (in terms of depth and weight) is adequate in composite construction compared with conventional non-composite construction.
- As the depth of beam reduces, the construction depth reduces, resulting in enhanced headroom.
- Because of its larger stiffness, composite beams have less deflection than steel beams.
- Composite construction provides efficient arrangement to cover large column free space.
- Composite construction is amenable to *"fast-track"* construction because of using rolled steel and pre-fabricated components, rather than cast-in-situ concrete.
- Encased steel beam sections have improved fire resistance and corrosion.

Shear connectors in beams

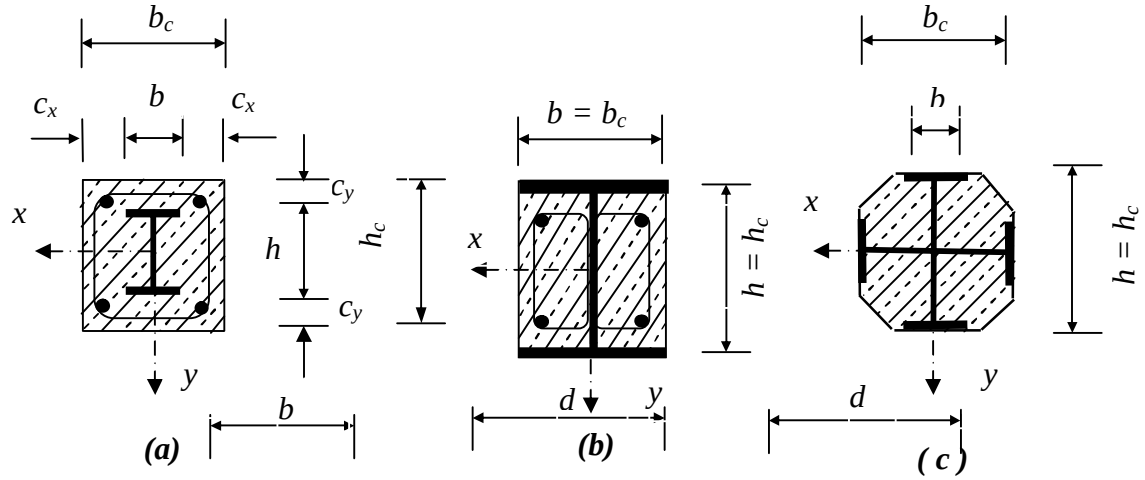
The mechanical connection between the slab and the beam at the interface to ensure composite action is called Shear Connectors. The total shear force at the interface between a concrete slab and steel beam is approximately eight times the total load carried by the beam. These connectors are designed to (a) transmit longitudinal shear along the interface, and (b) Prevent separation of steel beam and concrete slab at the interface. There are two major types of shear connectors, namely Rigid Connector, Flexible Connector.

Rigid Connectors are the ones which, as the name implies, are very stiff and they sustain only a small deformation while resisting the shear force. They derive their resistance from bearing pressure on the concrete, and fail due to crushing of concrete. Short bars, angles, T-sections are common examples of this type of connectors. Also anchorage devices like hooped bars are attached with these connectors to prevent vertical separation.

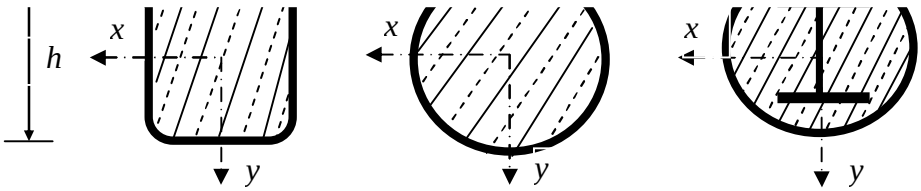
Flexible Connectors are welded to the flange of the steel beam. Headed studs, channels come under this category. They derive their stress resistance through bending and undergo large deformation before failure. The stud connectors are the types used extensively. The shank and the weld collar adjacent to steel beam resist the shear loads whereas the head resists the uplift. This type of shear connectors has been adopted in the handloom Complex.

Concept of Composite Construction in Columns

A steel-concrete composite column is a compression member, comprising either a concrete encased hot-rolled steel section or a concrete filled tubular section of hot-rolled steel and is generally used as a load-bearing member in a composite framed structure. Typical cross-sections of composite columns with fully and partially concrete encased steel sections as illustrated in Fig. 1. Handloom Complex have adopted Type (a) as illustrated below with certain variations. Fig. 2 shows three typical cross-sections of concrete filled tubular sections. Note that there is no requirement to provide additional reinforcing steel for composite concrete filled tubular sections, except for requirements of fire resistance where appropriate.



Typical cross - sections of fully and partially concrete encased columns



Typical cross-sections of concrete filled tubular sections


In a composite column both the steel and concrete would resist the external loading by interacting together by bond and friction. Supplementary reinforcement in the concrete encasement prevents excessive spalling of concrete both under normal load and fire conditions.

In composite construction, the bare steel sections support the initial construction loads, including the weight of structure during construction. Concrete is later cast around the steel section, or filled inside the tubular sections. The concrete and steel are combined in such a fashion that the advantages of both the materials are utilized effectively in composite column. The lighter weight and higher strength of steel permit the use of smaller and lighter foundations. The subsequent concrete addition enables the building frame to easily limit the sway and lateral deflections. There are various *advantages* of composite columns which can be elaborated as below:

- Increased strength for a given cross sectional dimension.

- Increased stiffness, leading to reduced slenderness and increased buckling resistance.
- Good fire resistance in the case of concrete encased columns.
- Corrosion protection in encased columns.
- Significant economic advantages over either pure structural steel or reinforced concrete alternatives.
- Identical cross sections with different load and moment resistances can be produced by varying steel thickness, the concrete strength and reinforcement. This allows the outer dimensions of a column to be held constant over a number of floors in a building, thus simplifying the construction and architectural detailing.
- Erection of high rise building in an extremely efficient manner.
- Formwork is not required for concrete filled tubular sections.

Special Features:

There are various special features for this building. The unique amongst them from structural engineering point of view is the connecting corridor between the two super-structure towers. Another important aspect is the fact that, the building was initially conceived in RCC. Later as the requirement of more column free area was envisaged, it was decided to adopt steel-concrete composite construction. Thus there are various locations, where the column to column spacing is 12.0 meters. The floor to floor height of the building is also more than conventional to allow for provision of Ventilation Ducts and other services like lighting arrangement and Fire Water lines above the False Ceiling level. The entire Architectural façade and finishes have been conceived keeping in mind, that the building will be basically housing handloom emporiums. Therefore the outside façade will have various Architectural Murals which will convey the rich heritage of Indian culture in general as also the various handloom extravaganza of the nation.