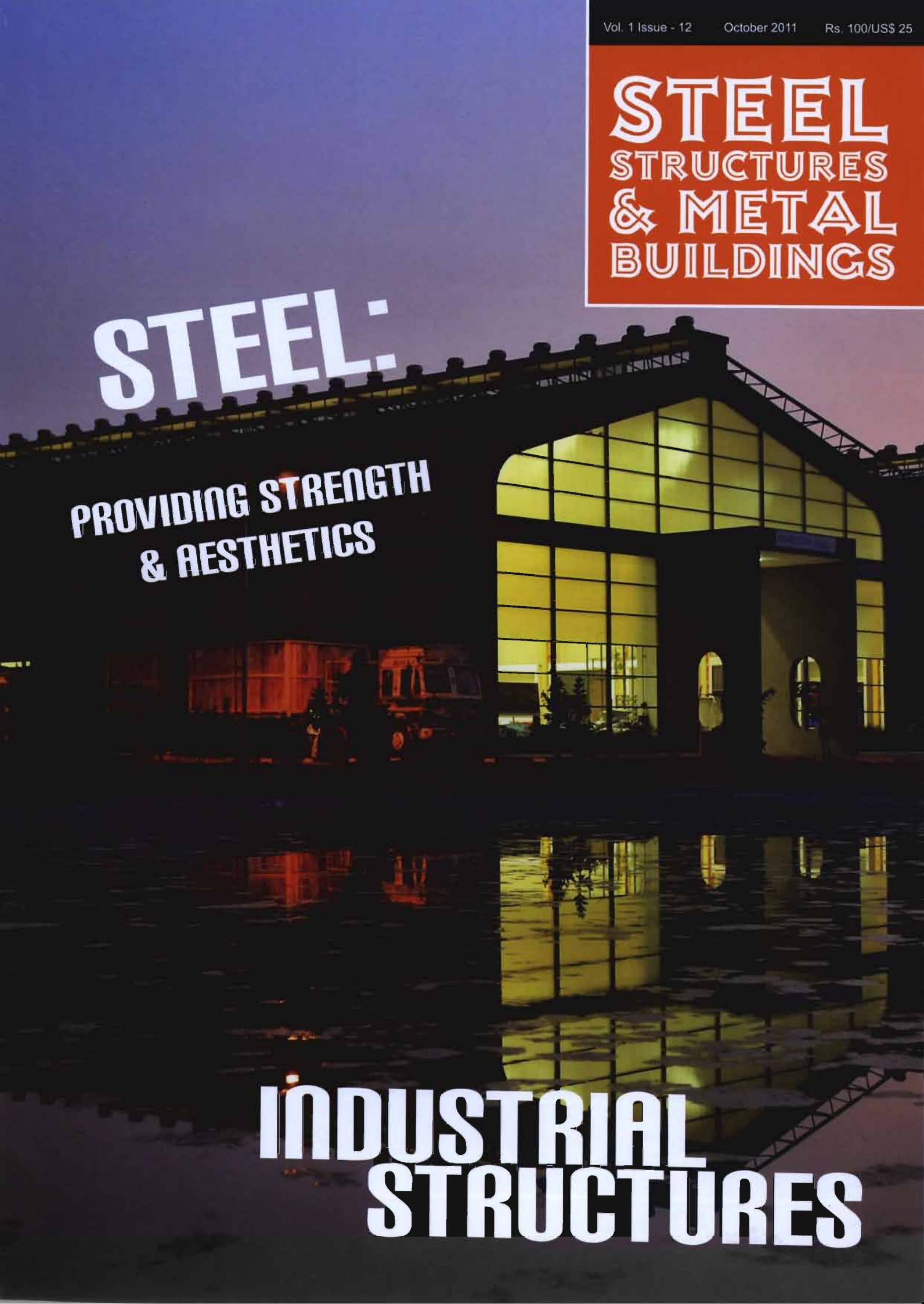


STEEL STRUCTURES & METAL BUILDINGS

STEEL:

PROVIDING STRENGTH
& AESTHETICS

INDUSTRIAL STRUCTURES





KHS Machinery Plant

A COMPLEX AND INNOVATIVE
STRUCTURE PAR EXCELLENCE



Tata Structura Hollow Section Specifications

132 x 132 x 5.4
72 x 72 x 3.2
49.5 x 49.5 x 2.9

Fact File

Client
KHS Machineries Ltd, Hirapur, Gujarat

Architect
HCP Design and Project Management Pvt Ltd

Structural Consultant
N. K. Shah Consulting Structural Engineers

Project Management
HCP Design and Project Management Pvt Ltd

Project Contractor
B. P. C. Projects

Steel Suppliers
Tata Structura & Jindal Steel & Power Ltd

Steel Tonnage
600 tonnes (Tata Structura)

Built up Area
18750 sq mtrs

Project Timeline
14 months

Project Cost
Rs 25 crore



KHS GmbH is one of the global market leaders in the manufacturing of filling and packaging machinery. During the late 19th century, the group's expansion into the Asian markets resulted in a joint venture between KHS GmbH (a 100 per cent subsidiary of Klöckner-Werke AG) and Mamata Group of Industries to form 'KHS Machinery Pvt Ltd'. The group commissioned HCP Design and Project Management Pvt Ltd (HCPDPM) from Ahmedabad for the construction of a bottling production plant in a green field site at Hirapur, Mehemdavad, in Gujarat.

The Program

The clients wanted to set up an innovative and efficient productive facility which would be completed as quickly as possible. The aim was to create an eco-friendly highly productive workspace which could utilize maximum natural

light and ventilation. KHS Machineries Pvt. Ltd. wanted to utilize this principle to provide absolutely comfortable working space with tremendous energy saving. Due to their business compulsions, the clients wanted a clean roof, so that no birds can get inside and create their perches. The program included production areas, utility blocks, stores for raw material, canteens, paint shop, a training centre, administrative offices and change/toilet areas.

Architectural Splendor

Spread over sprawling 9.05 hectare plot, the production facility designed by HCPDPM covers 18,750 sq. meters. The architects responded to the challenge with a design which consists of four identical sheds spanning 27m in width by 120m in length. The sheds are interspersed by 9m wide courtyards. The production facilities are housed in the north side

of the shop floor in an innovative steel structure, while the southern bay in reinforced cement concrete structure houses the stores, office spaces and other support facilities.

The architects proposed the unique inverted truss roof canopy to achieve a clean undersurface of the roof and to avoid a false ceiling. The steel columns and trusses, which span 27m, appear above the roof externally creating a simple yet architecturally striking vocabulary. A gantry with a capacity of 20 tonnes runs along the entire clear span making the production area flexible. To achieve precision in fabrication, templates were prepared for all steel members including jigs.

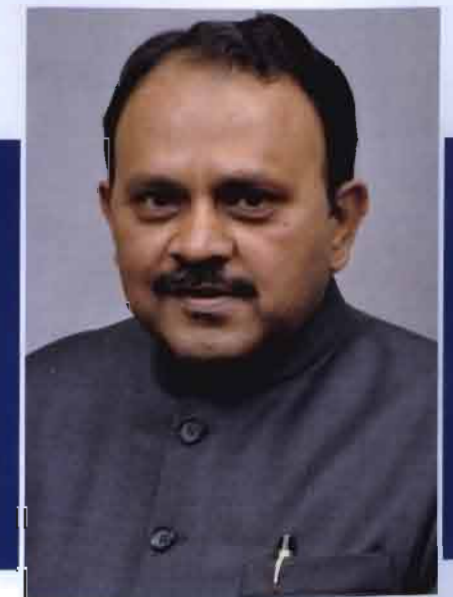
Steel was selected as the construction material by the architects to meet the project's unique requirements of large clear span, ample height, clear headroom and column free shop floor. In

VIRTUOSO QUOTE

Y. R. Sharma

Managing Director, KHS Machineries Pvt Ltd, Ahmedabad

“The KHS Machinery Factory building aligns with nature's beauty and efficiency. It is undoubtedly one of the best eco-friendly factory buildings created for an engineering industry in India. Our goal was to create an eco-friendly highly productive workspace which could utilize maximum natural light and air ventilation. Due to our business compulsions, we wanted clean roof so that no birds can get inside and create their perches.”





In addition to meeting the functional challenges, the use of steel as the construction material helped to meet the time constraints of the project. While the steel super structures were prefabricated, the concreting work for the foundation was carried out simultaneously. The modularity of design, choice of material and efficient project management helped complete the project within a short time frame.

Structural Succinct

The structural system was designed so that the three structural elements viz. gantry supports, column supports for the roof canopy and 12 feet high brick wall supporting windows and other ventilation elements rest on a common foundation. This was especially challenging as the 20 tonne crane inside the factory, sits on the cantilever columns of 7 meters height which is free from main steel portal. This unique design separates vertical cladding sheeting and windows from any vibrations of crane. The design methodology breaks away from the traditional method of construction in order to meet the unique functional requirement of this industrial unit.

Comfort Driven Spatial Arrangement

The spatial arrangement is aimed at creating a comfortable interior environment. The northern end of the sheds are completely glazed, allowing ample uninterrupted north light to filter into the production areas to provide even day-lighting while mitigating heat gain. During day time the building never utilizes electrical lights in any of the sections of factory buildings.

Even in their engineering design office, they hardly use electric lights where minimum light intensity required for precision work is 400 lux. The location of the sheds was determined with the aim of retaining existing trees and landscape.

The space between the sheds allow for natural ventilation of the interior spaces which is also augmented by stack driven ventilation. Stack effect is temperature induced and the metal super structure accelerates the heating up of the air inside the shed. A bank of ventilators sitting on the crown of each roof aid in exhausting this hot air while the cooler, denser air from the shaded open spaces are drawn into the production areas. Further, the roof canopy has been designed so that its shape assists in directing the draft towards the crown.

Significant Features

- One of its kind of 'Exposed Steel Structure'
- Huge clear span of 27 meters
- Metal sheeting done from inside of the shed making it completely "Birds Free" facility for export oriented industry
- Planned to provide ample daylight and ventilation during working hours
- 20 tonnes gantry supported at 7.0 meters height from floor over cantilever steel columns
- Vibrations transmission to sheeting, steel windows and to steel portal due to gantry movement was completely eliminated by this unique approach
- First time use of TATA Weather Resistant Steel Boxes in India of over 600 tonnes with copper content to retard weathering process
- Unique fixing details of electrical pipes and lights to the sheeting
- Glazed gable ends make it architectural marvel in night and energy efficient in daytime
- A perfect illustration of innovation in fabrication and erection
- Overhead cranes are designed and installed on pillars which are not connected to the roof

VIRTUOSO QUOTE

Kunal Patel

Principal Architect & Senior Associate, HCP Design and Project Management Pvt Ltd

“The simple idea of using inverted steel trusses over metal roof canopy, transformed the production facility from a conventional shed into an architecturally striking form. The palette consists of functional elements - outer steel columns and trusses, metal roof canopy, north-facade glazing, gantry support columns and large openings to allow material handling which have been brought together harmoniously.”



Conquering Structural Challenges

One of the major challenges involved was in achieving the client's targets, especially in designing the external trusses to provide stable leak-proof roof. Another major challenge was to achieve zero vibrations in building of production hall despite of handling of heavy overhead cranes.

Due to its unique exposed structural steel design, the main concern was corrosion to steel structure even though site was not in the vicinity of coastal region. This was taken care of by using, first time in India, weather resistant steel hollow boxes of TATA make which has copper content that retards corrosion process, and hence better durable structure was achieved.

Since the architects proposed to fix the metal sheeting from inside, top compression members of the portals which are usually laterally supported by purlins was not the case. To overcome this issue, additional members were introduced to check unsupported length of the members and thus, making it very sleek in design. The structural steel portal with high gantry loads lead to lot of vibrations at the time of gantry movement which gets transmitted into steel portal, sheeting and even window sections. This

in turn leads to unacceptable humming noise and loosening of sheets, and in turn leakages at a longer run. This problem was completely eliminated by separating portal columns and gantry columns. These gantry columns were separated from window sections by introduction of RCC C-shape member around gantry columns.

The requirements of 20-tonne gantry to run at approximately 7 meter height on cantilever columns had few logical issues. The biggest challenge was to have cantilever column and to have deformation at the top well within the allowable limits, so that alignment of gantry is not broken. Also, the gantry girder could not laterally be braced to portal columns, which is the usual case in any portal frames, and in this case the sheeting comes between portal and gantry girder. Anything which could puncture sheeting may lead to leakages at later stages which were very well taken care by uniquely designed system of electrical fixtures, pipes and also gantry columns and girders. The complete metal sheet fixing was done by making scaffolding of full height.

Innovative Material

For the first time in India, steel hollow sections with copper content was used in this project.

Over 600 tonnes of weather-resistant Tata Structura steel box hollow sections have imparted a rare grandeur to this particular structure. The structural elements are exposed to the atmosphere while steel hollow sections ensure good corrosion resistance to the entire building.

Award-Winning Project

The KHS Machineries factory building is an award-winning project showcasing the complexity of design and unique usage of Tata Structura steel hollow sections. The design of this thoughtfully executed project melds form, function and construction to create a unique industrial project. The engineering uniqueness of the project has been recognized by following awards received by the Structural Designer of N. K. Shah Consulting Structural Engineers:

2010

Young Consultant Award (Anal Shah) by Consulting Engineers Association of India (CEAI)

2007

First prize in National Competition for professionals on steel design and construction by INSDAG

VIRTUOSO QUOTE

Anal Shah

Structural Designer,

N. K. Shah Consulting Structural Engineers, Ahmedabad

“The KHS Machineries Ltd factory building has witnessed heavy monsoon showers and no problems of leakages are reported as yet. This project very well demonstrates its uniqueness in usage of steel structure by making it more aesthetically appealing, structurally efficient and energy efficient. It is a unique architectural and structural marvel of Birds Free Industry.”

