INSDAG Publication No. INS/PUB/160

INSDAG Yearbook 2022-2023

Institute for Steel Development and Growth

793, Anandapur, Ispat Pragati Bhawan
KOLKATA – 700 107
Email: info@insdag.com; Website: www.steel-insdag.org

INSDAG Yearbook 2022-2023

– Summary

December 2023

Publication Number INS/ PUB/ 160

Price of Each Article: Rs.200/-

Price of Full Book: Rs. 1000/-

Institute for Steel Development and Growth
"Ispat Pragati Bhawan",793, Anandapur, Kolkata - 700 107
E-mail: info@insdag.com, membership@insdag.com
Web Site: www.steel-insdag.org

INSDAG Yearbook 2022- 2023

Contents

INSDAG Yearbook 2022- 2023

Summary

Risk Mitigating Strategic Approach to Asset Integrity Management [AIM]: A Case Study for the Replacement of a Junction House

Manikanta Kapaganti[1], Bhaswati Jha [2], Runu Dutta[3], Sayak Banerjee[4],
Shalini Bandyopadhyay[5], Manos Kumar De [6]
Department of Civil/Structural Engineering; Email : manikantak@tce.co.in;
Tata Consulting Engineers Limited

Abstract:
All structures have their intended design life. However, with good maintenance, some may perform well beyond their designed life span. Thus, good maintenance policy requires continuous attention on any performing asset as per its role in the overall system. In this case, in an **Integrated Steel Plant** in **Europe**, many structural members and base of a **Junction House**, which is part of the coal supply system to the **Coke Oven battery** was found severely damaged. These damages, if not attended in time, may cause sudden local failure anywhere in the damaged structure causing disruption in coal supply to Coke Oven, which is detrimental for the plant operation. Thus, Asset Integrity management [**AIM**] practice demands mitigation of weakness caused by the damages and attending the same on localised basis or in entirety. The said junction house is one of three such houses, holding one reclaim conveyor fetching coal from coal stockyard, supplying same to another through conveyor that takes coal to the junction house before **Coal Blending Bunker Building**. The junction house as such is apparently small being 6400x6000x15200mm high with only two complete floors but plays essential role in coal delivery system which cannot be interrupted for long time. Repair of individual members could be the option for restoration. However, considering prolonged site work increasing expenses and hazard, **replacement** of the entire junction house was considered. Essentially, during replacement of junction house, coal supply process need to be halted. Thus, time sanctioned for replacement was short and commencing the work in stipulated time required meticulous planning, **micro-scheduling** with some time buffer, data collection and process detailing. Ensuring full **safety**, minimum interference in the conveyor system and **cost viability** was a challenge in the project which was overcome through detail design and activity planning.

[1] Design Engineer, Civil & Structural

[2] Subject Matter Expert, Civil & Structural

[3] Assistant General Manager, Civil & Structural

[4] Assistant General Manager, Civil & Structural

[5] Assistant General Manager, Civil & Structural

[6] Discipline Head

High-Strength Constructional Steel: An Overview

Dr. Kiran B, Associate Professor, Department of Civil Engineering,
Dayananda Sagar College of Engineering, Bangalore-560078, Karnataka, India

Abstract:
High-strength constructional steel is a category of constructional steels that possess a minimum yield strength of 460 MPa. Yield strength represents the stress level at which plastic strain begins, resulting in permanent deformation in the designated steel components. In comparison to conventional mild steels, which have yield strengths ranging from 235 to 355 MPa and carbon content below 0.3%, high-strength constructional steels exhibit higher yield strength while being lighter in weight under the same load. Furthermore, the emergence of advanced high-strength constructional steel, also known as high-performance steel, allows for an optimized combination of strength, weldability, ductility, toughness, corrosion resistance, and formability. These steels hold great potential for various significant projects worldwide.

In conclusion, high-strength constructional steel offers numerous advantages that make it a viable choice for various construction projects. Its cost-effectiveness is evident, as higher yield strength results in reduced plate thickness and member size, leading to material and weight savings. This cost-efficiency becomes particularly significant for non-buckling steel members, long-span bridges, and robust columns in high-rise buildings.

Moreover, the utilization of high-strength constructional steel contributes to environmental sustainability. By requiring fewer resources to fulfil structural functions, it helps mitigate the environmental impact associated with steel production, including greenhouse gas emissions and particulate pollution.

Architecturally and structurally, high-strength constructional steel provides several benefits, including serving as an alternative to conventional mild carbon steels, enabling increased usable floor area, avoiding welding issues, and facilitating cost-effective transportation, erection, and foundation processes. Additionally, its implementation enhances seismic performance by reducing the mass of structures and improving their resistance to earthquakes.

However, despite the advancements in high-strength constructional steel, certain limitations exist in terms of current design codes and seismic design requirements. Further research is needed to determine the compatibility of high-strength constructional steel with existing codes and its suitability for seismic zones. While high-strength constructional steel has gained popularity in the construction industry, it still represents a small fraction of the overall steel market.

Case Study on Restoration Work for Critical Plant Supporting Age-old Asset in an Integrated Steel Plant under Site Specific Process and Acute Space Constraints

Bhaswati Jha, Manos Kumar De, Arpan Sarkar, Shalini Bandyopadhyay
Department of Civil Engineering; Tata Consulting Engineers Limited; Email: shalinir@tce.co.in

Abstract:
Many age-old industrial steel structures continue to remain in service, often beyond their design life. In active plants, they frequently have uses in addition to or different from those for which they were originally designed. Many of these, due to environmental wear and tear, develop risks for continued use and occasionally become potential threat for the process supports and the working force. With an eye towards reduction in carbon footprint, worldwide, all efforts, at present, are aimed towards life extension of existing assets for repurposing and reuse.

In an integrated steel plant, blast furnace is the heart of the steel making process. The iron making operation of blast furnace involves many hot and cold fluids, both liquid and gaseous, as input and byproduct of the process. The associated pipelines and electrical supply system are numerous, of great importance and need to have a stout and rigorous support system. In old steel plant, often, being open to air arrangements and subjected to corrosive environments, such support system become heavily damaged, leading to unsafe structural condition and requires major refurbishment with live utilities supported on them. Retrofitting the concerned asset, maintaining equipment and personnel safety and continuity of operation, requires thorough study of the damages, collecting details of all utilities, identification of structural support systems with the load flow path, judicious planning for access management for repair works and temporary support planning during replacement of components. A systematic approach towards such repurposing and structural restoration work is gradually gaining importance and acceptance to replace the “Scrap and Build new” concept.

The aim of the paper is to present in detail the restoration work that was required for retrofitting an old, abandoned material handling system in a congested disposition, being used presently as a yard piping structure, next to a working blast furnace in an integrated steel plant. The rational and judicial approach adopted herewith may find its applicability elsewhere under similar site-specific process and space constraints under a life cycle asset management program.

P-Delta Effects on SCWB & WCSB Steel Frames Subject t to Seismic Loading

Arup Saha Chaudhuri[1]
Rituparna Chatterjee[2], Tanmoy Banerjee[3], Uttarayan Chakrabarty[4]
[1]Professor, Dept. of Civil Engg., Techno Main Salt Lake, Kolkata, India
[2,3,4]M.Tech (Structure), Dept. of Civil Engg., Techno Main Salt Lake, Kolkata, India
Email: arupsc@rediffmail.com

Abstract:

With the increase in population worldwide, the demand for modern houses is increasing. Earthquakes take a huge toll on life and property. Since the effect of seismic forces on structures is quite significant, it is important that the design of the structures must be done in the best possible way to take into account these effects and thereby aiming for an adequate structural response. In this discussion we will address in a concise way, two methods in the design of steel structures, which are linear analysis and second order effects (P-Δ). It is known that a nonlinear analysis is more accurate than a linear analysis, but on the other hand is an inefficient analysis in terms of time consuming with calculations and computer memory. So static P-delta analysis is considered here and compared with the linear response spectrum analysis of Strong Column Weak Beam (SCWB) and Weak Column Strong Beam (WCSB) steel frames.

Continuously Reinforced Concrete Pavement (CRCP) – Benefits on Life Cycle Cost Basis

Pydi Lakshmana Rao
Institute for Steel Development and Growth, Kolkata

Abstract:

The investments in infrastructure projects especially highway projects are very high and hence proper investigation needs to be made while choosing the right type of highway structures like bridges, roads etc. One has to carefully exercise the choice, considering various factors such as traffic, environmental conditions, availability of materials, initial cost of construction, serviceability life of structure, cost of maintenance, road user cost, resistance to overloading and life cycle costs.

Fuel saving and vehicle operating costs also play an important role in deciding the most optimum choice. Any little amount of fuel saving is a huge benefit to the nation, because major portion of oil is imported.

Life Cycle Cost or whole life cycle costing examines the cost of a project from inception to disposal including the direct cost of constructing and maintaining a highway and the indirect costs imposed on society and the environment by its use and operation (e.g. traffic delays, accidents at road works, skidding accidents, fuel consumption and tyre wear etc).

Bitumen pavement is a flexible pavement widely used in India due to its lower initial cost. Concrete Pavement is very economical on LCC basis. Continuously Reinforced Concrete Pavement (CRCP) is highly recommended considering its durability and virtually long maintenance free service life.

The detailed LCC cost calculations of a typical pavement of 4 lane carriage way 18m wide road has been given in the article. Among the three types of road variants, direct cost of bitumen road comes out to be the lowest; however this is very uneconomical on the long term i.e. on Life Cycle Cost basis due to shorter life, higher maintenance costs and increased fuel consumption of vehicles.

Construction cost (considering reduced interest burden due to early completion) of CRCP is about Rs.429 Lac (approx. 42%) more than that of bitumen road. However, on life cycle cost basis, bitumen road is very expensive (higher LCC by about Rs. 19.5 crores per km) than CRCP over a life span of 20 years has been estimated. In addition CRCP gives excellent riding comfort.

From the above it is very clear that the lower initial cost may not always the best cost effective option considering various other costs involved in the whole life time. Hence, it is always advisable to calculate the life cycle costs of all possible alternatives for all important public infrastructure projects. By making the LCCA mandatory we can save money and resources of the nation.

Investigation of Cover Concrete Failure of Door Lintel

Nandita Kayal, Manashi Adhikary, Goutam Mukhopadhyay, Dheeraj Kumar, Nazmul Hussain, Anup Kumar
Tata Steel Limited, Jamshedpur

Abstract:

In the current study, the authors have studied a premature failure of a concrete cover thickness of a door shade, projected from lintel of a laboratory building. Heavy rain fall preceded the loosening and falling of a sizable mass of concrete from the shade. Detailed investigation was carried out to understand the root cause of this failure using Chemical, SEM-EDS and XRD analyses of both failed concrete and rebar.

Failed and exposed region (approx. 3 sq ft.) revealed spalling of concrete and heavy rusting of the embedded reinforced rebar, associated with volume expansion (by corrosion products) and reduction in its actual diameter. Rebar core microstructure was Widmanstatten ferrite and pearlite. Rim revealed the presence of tempered martensite with severely serrated surface attributed to flaking/ layer-wise corrosion of rebar, which weakens the rebar-concrete bonding. However, no significant reduction in tensile properties was observed, which may be attributed to higher quenching rate and inadequate tempering, resulting in higher rim thickness (by 0.2-0.5mm) and hardness (by 30-40HV).EDS spectrum revealed traces of Fe-oxide in the red remnant of the rebar observed over the concrete surface. However, presence of any corrosive reagent was not found. Corroded rebar exhibited several layers of corrosion product with higher oxygen content at the outer most surface.XRD analysis of rusted rebar revealed Ferrihydrite formation indicating the possible use of lower pH concrete (lower cement content) at the time of construction. This was further confirmed by Chemical analysis. No color change of failed concrete in carbonation test indicated whole cover concrete of the shade was completely carbonated. These analyses help to conclude that use of lower cement content led to higher porosity resulting in early hydration and carbonation of concrete as well as rebar, which reduced the strength and inadequate quenching-tempering condition of rebar aggravated the corrosion propensity.

Profiled Sheets – Structural use in Construction

Arijit Guha
Institute for Steel Development and Growth, Kolkata

Abstract:
As the name itself indicates, 'Profiled Sheets' are made of steel thin sheets rolled to a particular profile, to give a geometrically aesthetic look to the sheet, as well as to develop better load carrying capacity from structural point of view. The modern day colour coated sheets which are being manufactured by various Indian companies are practical examples of profiled sheets.

These sheets are now-a-days used as roofing and wall cladding facade in large industrial and commercial buildings. The choice of pre-painted colour coated sheets over the conventional corrugated galvanized iron sheets (commonly known as CGI sheets) or the erstwhile asbestos cement sheets (commonly known as AC sheets) as roofing or wall cladding façade, is due to the fact that these sheets are lighter, more flexible (more ductile), yet stronger in terms of load carrying capacity. They are structurally more durable and last but not the least, they give an aesthetically beautiful look to the completed structure.

These sheets are mainly suitable for use as roofing or wall cladding. It is also used as sacrificial deck shuttering during construction of reinforced concrete slab in industrial and large commercial buildings. Some of these sheets come with embossments on its surface and these are manufactures for construction of composite slabs, which are manly used in the large commercial structures.

Profiled steel sheets have varied function in the field of structures mainly for industrial and commercial ones. For industrial buildings, plain profiled sheets are mainly used as façade, whereas for commercial buildings, other than for façade, they are also used as sacrificial deck shuttering and also as deck sheets for composite slabs. In the latter case embossed profiled sheets are used. In the modern perspective, the use of these sheets has increased manifold and lot of major and small manufacturers are coming out with these sheets in the market.

Procedure for Determination of the Nominal Compressive Strength of Gusset Plates using IS: 800-2007 Provisions

Raghavan Ramalingam[*1], S. Arul Jayachandran[2]

[1] Assistant Professor, Department of Civil Engineering, National Institute of Technology Tiruchirappalli

[2]Professor, Department of Civil Engineering, Indian Institute of Technology Madras

* Corresponding Author email: raghavanr@nitt.edu

Abstract:

The design of gusset plates in braced frames and trusses is often sidelined by designers, in many cases satisfying the sufficiency of the bolt or weld groups while not the gusset plate itself. Gusset plate failures can occur due to one of many causes that are expected in the main structural member itself and the type of structure – braced frame or truss. When a compression member is designed, the strength of the associated gusset plate is rarely checked due to the lack of codal provisions. In other words, gusset plate stability checks are absent from design from the design of gusset plates.

Attention to the compressive strength of gusset plates becomes important in cases where out-of-plane movements can be expected, or when the length of free edge or length between the end of the connection and the supported edges is large. Therefore, a procedure for determining the compressive strength of gusset plates used in braced frames based on existing provisions in IS:800-2007 has been illustrated in this article. The clauses in IS:800-2007 that mandate this and procedures that are present or proposed in other design guidelines and literature have been discussed.

Three different approaches have been discussed along with detailed calculations – IS:800-2007 based equations, FHWA equations and Plate buckling approach. Within the former two approaches, Thornton (30° degree dispersion) and Modified Thornton (45° degree dispersion) have been compared as well. Though all column approaches are conservative, it is seen that, the Modified Thornton approach provides the best prediction for gusset plates that are not stocky, and therefore the provisions of chapter 7 of IS:800-2007 for compression members can be readily used to estimate the capacity of gusset plates in compression.

Comparison of Buckling Behaviour of 60^o and 90^o Angle Sections

R. Balagopal, N. Prasad Rao, R. P. Rokade and G. S. Palani

Scientist
CSIR-Structural Engineering Research Centre, Taramani, Chennai

Abstract:

The rapid growth of telecommunication sector requires large number of antennae supporting towers. These towers have either square or triangular configuration. Triangular-based towers results in significant reduction in weight of the structure compared to conventional square-based towers. The 60^o angle sections for triangular towers are manufactured by either hot rolled or by cold forming process. Buckling behaviour of cold formed 60^o angle sections are studied in the present investigation. The compressive strength of these angle sections are governed by torsional-flexural buckling. Numerical investigation carried out in NE-NASTRAN to determine the buckling strength of angle sections V 38x38x3.2 mm and V 51x51x4.8 mm for which test results are available in literature. It was observed that both numerical results closely match with experimental results in the elastic buckling range. Further comparative studies have been carried out to understand the buckling behaviour of 60^o and 90^o cold formed angle sections with 1m effective length. It is observed that buckling of both these angle sections are governed by torsional-flexural buckling.

Institute for Steel Development and Growth

Published By: INSDAG INSDAG Publication No. INS/ PUB/160