

INSDAG Yearbook 2023-2024



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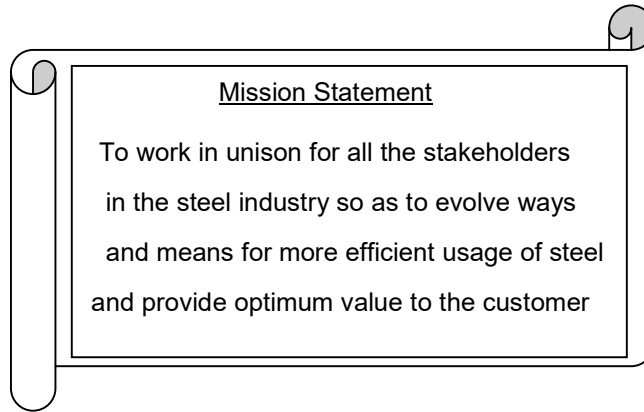


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PREFACE

The primary drivers of steel consumption in the country would be massive infrastructure as well as the progress of a number of steel intensive structures like machinery & equipment, consumer durables and automobiles. INSDAG Yearbook 2023-2024 contains the technical articles from experts in steel industry. The document contains articles on various topics.

We believe that the range and scope covered by the technical papers in the yearbook covering the various topics will definitely create interest in steel fraternity and increased use of steel intensive structures. **The topics covered are:**

1. STEEL CONCRETE COMPOSITE HIGH-RISE BUILDING WITH STEPPED ARCHITECTURE FOR EARTHQUAKE PRONE AREAS

by Arup Saha Chaudhuri, Professor, Department of Civil Engineering, Techno Main Salt Lake, Kolkata, Deepjyoti Roy, Supriyo Maity, M.Tech (Structure) scholar, Department of Civil Engineering, Techno Main Salt Lake, Kolkata, E-mail: arupsc@rediffmail.com

2. OPTIMUM ENGINEERING SOLUTION FOR EFFICIENT LOAD REDISTRIBUTION OF SUPERSTRUCTURE OF PROCESS BUILDING

by Lalima Chatterjee, Purnendu Bhandari, Manos Kumar De
Department of Civil Engineering, Tata Consulting Engineers Limited
Registered Office: Elphinstone Building, 10, Veer Nariman Road, Mumbai 400 001, India

3. INVESTIGATION ON DYNAMIC AMPLIFICATION OF STEEL GIRDER RAILWAY BRIDGE USING A HIGH-FIDELITY MODEL UNDER A HIGH-SPEED MOVING LOAD

by Ashwani Sharma¹, Gaurav Singh², and Mahendra Kumar Pal^{1,*} ¹Indian Institute of Technology (BHU), Varanasi 221005, India, ²Delhi Metro Rail Corporation, New Delhi

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4. FINITE ELEMENT ANALYSIS OF WELDED CONNECTION PLATES: A COMPARATIVE STUDY USING ANSYS

by Er. Basava Vamsi Krishna (PhD), Scholar, Department of Civil Engineering, S R University, Ananthasagar, Hasanparthy, Hanumakonda 506371, Telangana, India, Email Id: 2305c10005@sru.edu.in

5. STRENGTHENING PROCESS EQUIPMENT SUPPORT STEEL STRUCTURES IN EXISTING PLANT FOR SUSTAINABLE OPERATION

by Sunil Sahoo, Mrinal Rathaur, Ankit Sonu and Manos Kumar De,

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6. DYNAMIC WIND EFFECTS ON STEEL SLIPFORM STRUCTURE FOR CHIMNEY CONSTRUCTION

by Soumya Bhattacharjya, Ph.D. ¹, Swapnil Basu ² and Subham Sinha ³

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By Debmallya Dutta, Saikat Hatui, Manos Kumar De;

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by Arth Harish Belvi and Dr. Aritra Chatterjee, Department of Civil Engineering, Indian Institute of Technology Kharagpur

9. FIRE SAFETY OF STEEL STRUCTURES

by Tanmoy Konar, PhD; Executive Engineer, West Bengal Police Housing and Infrastructure Development Corporation Limited, Salt Lake, Kolkata, India, 3tanmoykonar@gmail.com;

Aparna (Dey) Ghosh*, PhD; Professor, Department of Civil Engineering, Indian Institute of Engineering Science and Technology, Shibpur, Howrah, India, aparna@civil.iiests.ac.in; *Corresponding author

10. DESIGN OF TRUSSES – AN OVERVIEW

by Kavitha R; Assistant professor, Department of Civil Engineering, KPR Institute of Engineering and Technology, Coimbatore, Tamilnadu 641407, India, * E-mail: kavitha.r@kpriet.ac.in

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By Pydi Lakshmana Rao, Institute for Steel Development and Growth, Kolkata

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STEEL CONCRETE COMPOSITE HIGH-RISE BUILDING WITH STEPPED ARCHITECTURE FOR EARTHQUAKE PRONE AREAS

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Summary

In structural engineering, steel-concrete composite structures are those types of structures where we use these two materials efficiently in the construction. They act as a single unit in which steel is effective on tension side and concrete is effective on compression side. In this paper, the proposed 22 storey high-rise building frame is made of structural steel columns and steel beams with concrete slab composite floors. Stepped Architecture is one of the ideal concepts of construction to stabilize any framed structure. The bottom portion should be much wider than the top portion of the structure in this concept. This concept is very suitable for high-rise buildings in earthquake prone areas. We will discuss about composite construction and stepped architecture concepts in detail and will show how we can apply both of these concepts in high-rise building to work efficiently. Purpose of this paper is to design and analyze a two dimensional building frame under high seismic zone without providing any extra seismic resisting system.



Optimum Engineering solution for efficient load redistribution of superstructure of Process Building

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Summary

The value-added proposition of providing alternate load path to relieve overstressed bracing members that enabled the process plant to install new and updated equipment for better operation is accepted by Owner. It has facilitated the plant to be commissioned early enabling advancement of production. TCE has also correctly verified the additional load on existing foundations to ensure that the pile capacity is not exceeded and have received appreciation from customer for the solution. The cost saving achieved in terms of advanced production has been verified with plant operation team by the design engineers and it is found that substantial cost benefit to the tune of INR multiple crores has been achieved with the design intervention.

Steel as material of construction was an apt choice for this structure and is thus highly favoured amongst structural engineers especially in heavily loaded construction and where future or new requirements need to be provisioned for. The ingenious solution provided in this case allowed the reuse of existing structure for new process operation with new equipment with heavier loads and manageable structural modification that also resulted in time and cost savings.

INVESTIGATION ON DYNAMIC AMPLIFICATION OF STEEL GIRDER RAILWAY BRIDGE USING A HIGH-FIDELITY MODEL UNDER A HIGH-SPEED MOVING LOAD

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Summary

The growing need and interest in high-speed trains in India require that new tracks be laid or existing tracks be strengthened, designed, and constructed for heavy axle loads moving at low speeds. While the former option is not economically viable, the latter has been adopted with many Vande Bharat trains running on existing railway tracks. With the introduction of semi-speed Vande Bharat Trains on existing railway tracks, the probability of amplified vibrations manifests in multiple ways. To ensure the safety of these trains, it is essential to have a performance assessment of existing bridges in these tracks with particular emphasis on the dynamic amplification and possibility of resonance at the speed of 130 Kmph or higher. In this study, the response of the steel girder railway bridge is investigated using a high-fidelity finite element model against moving load at a high speed. The FE model has been generated using three-dimensional quadratic tetrahedron elements. During mesh generation, proper concatenation of all the elements at the connections in the bridge is ensured.

An electric locomotive with ten coaches (17t axle load each) is used as a model train to calculate the total moving load. Time history analysis against moving loads has been performed using the commercial numerical tool. In the preliminary results, it has been observed that there is an amplification in vertical movement of the bridge span at a speed of 100 and higher. It is further noticed that the bridge continues to vibrate after the train passes.



FINITE ELEMENT ANALYSIS OF WELDED CONNECTION PLATES: A COMPARATIVE STUDY USING ANSYS

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Summary

Structural analysis of the loaded welded connection of plates requires the determination of the design strength of the plate specially in bridge Structures. Simple welded shear tab connections are used regularly in structural engineering practice. Many engineers who still use Allowable Stress Design use the elastic method in designing these connections. To determine the stresses in a plate at the welded joint of a simple shear tab connection using finite element analysis, and to compare those results to the simplified elastic analyses used in structural engineering practice. In particular we will look at the tension and compression stresses at the extreme fibers of the weld connection along with the shear stress at the middle of the weld. ANSYS will be used for the finite element analysis.

In conclusion, both the finite element analysis approach and the allowable stress design approach result in almost identical maximum shear stresses in the plate at the welded joint. The two approaches do not provide similar results for the maximum tension and compression stresses at the ends of the joint.

STRENGTHENING PROCESS EQUIPMENT SUPPORT STEEL STRUCTURES IN EXISTING PLANT FOR SUSTAINABLE OPERATION

Sunil Sahoo, Mrinal Rathaur, Ankit Sonu and Manos Kumar De

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Summary

In today's scenario the demand of refurbishment and retrofitting of various assets is gradually increasing in plant operation to satisfy economic and sustainability objectives. This requires deep technical knowledge and experience and application of good engineering principles. The case study presented here is unique and critical in nature. The engineering and erection status of the expansion project in integrated aluminium plant was at different stages of completion for more than a decade. It was a challenging job to find out the balance engineering and present condition of already erected steel structure based on which further detail engineering need to be completed to meet the demands posed by installation of new process requirement. In this journey, several difficult problems which were very critical in nature from safety point of view were identified. The project involved modification of ESP supporting structure without dismantling the existing room and modification of 98 m existing Stack supporting steel structure for creating a space of 15.75 m x 9.9 m at elevation starting from 22 m level by deleting all existing bracing & tie system and increasing unsupported length of column almost as 15.75m. It was very challenging to provide various tailor-made solutions to comply with present process requirement on case-to-case basis. The specific solution was provided matching with present site condition and fulfilling the present process requirement. This resulted in great value addition to the project to re-use the existing steel structure without dismantling existing room and stack supporting steel structure. The successful execution of the engineering demonstrates implementation of sustainability principles in engineering design.

DYNAMIC WIND EFFECTS ON STEEL SLIPFORM STRUCTURE FOR CHIMNEY CONSTRUCTION

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Summary

Steel slipform structures are inevitably required for tall concrete chimney construction. Often, such structures are designed without wind load. Even if wind load is considered, it is calculated by equivalent static method following IS: 800 (2007) or similar standards. However, at such great elevation, dynamic effects of vortex shedding are quite likely and may result in resonance when vortex shedding frequency matches with the natural frequency of slipform-chimney system. Moreover, vortex shedding involves many uncertain hazard parameters, which cannot be assessed with due accuracy (such as wind speed, natural frequency at the construction stage, etc.). Hence, this aspect is often neglected during slipform design. However, during occurrence of high storms, it is quite possible that such dynamic effect may result in catastrophic failure and large loss of human and money resources. Thus, this paper attempts to assess dynamic effects of vortex shedding on slipform structure and propose suitable magnification factor for design of slipform. A detailed stochastic modeling of vortex shedding effect is also investigated in the present article. The procedure is explained step-by-step through a practical example of a tall chimney-slipform system.

BUILDABILITY AND CONSTRUCTIBILITY CONSIDERATIONS IN DESIGN – CASE STUDY ON BENEFITS FROM EARLY IMPLEMENTATION

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Summary

In construction industry, architectural layout with design engineering and procurement along with construction are usually operated as two different sectors having different expertise that are involved during project lifecycle from conceptualisation to execution. Sometimes, due to difference in philosophy and execution plan between these two sectors, misunderstanding occurs and consequently productivity reduces which finally results in project implementation and dissatisfaction to the Owners. In this context, looking into various aspects of Constructability/Buildability right from the project conceptualisation stage plays a pivotal role in cost effective execution of project as well as reduction of material wastage keeping the project schedule almost/fully intact.

The case study in this article demonstrates introduction of constructability methodology right from the conceptual stage for an existing Integrated Steel plant project located in Europe without involvement of any contractor at engineering phase and later the concept outlined during engineering accepted by the fabrication and erection contractors. Finally, the structure was erected as per the constructability planning sketched during conceptual stage of engineering. These findings from the case study are summarised as few guidelines for the design engineers regarding how proactively and collaboratively constructability can be adopted at the very beginning of engineering.

LIVE LOAD REDISTRIBUTION STUDIES ON COMPOSITE PLATE GIRDER BRIDGES USING NON-LINEAR FINITE-ELEMENT ANALYSIS

Arth Harish Belvi and Dr. Aritra Chatterjee
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Summary

Live load distribution factors in steel-concrete composite plate girder bridges have been studied in the past both experimentally and numerically. Detailed studies on typical bridges have revealed that load distribution factors recommended in design codes are quite conservative. This paper studies the evolution of live load distribution in steel-concrete composite plate girder bridges, from deck cracking, to yielding initiation in steel girders, plastic hinge formation and finally, loss of system load carrying capacity. Geometrically and materially nonlinear finite element modelling is employed using commercial software ABAQUS for the analysis. The proposed modelling protocol, which includes nonlinear material modelling for both steel and concrete, is validated through studies on a typical bridge whose results are available in the literature. The validated modelling approach is extended to live load distribution patterns following recommendations given in IRC:6-2017, and applied to a typical Indian four-lane composite bridge with eight steel plate girders. The results indicate that AASHTO recommended live load distribution factors are conservative for the studied load pattern and bridge model throughout the response evolution from initiation of nonlinearity to ultimate system failure. The evolution of load distribution and the ultimate system failure mode are found to be dependent on loading pattern (IRC Class-70R vs Class-A) which is consistent with previous findings in the literature.



Fire Safety of Steel Structures

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Summary

Fire safety of buildings and other built infrastructure is a crucial aspect of design and construction, more so in densely populated countries such as India, in which the propensity of fire-induced loss in terms of human life and economy is very high. In recent times, steel structures have been rapidly gaining popularity due to their strength, ductility and versatility of use. However, in comparison to the ubiquitous concrete structures, steel structures pose unique challenges when exposed to fire. The rapid degradation in the properties of steel at elevated temperatures causes steel structures to be highly vulnerable to structural failure in the event of a fire. Thus, the performance evaluation of steel structures in fire scenarios necessitates a thorough understanding of various aspects associated with the behavior of steel as a material at high temperatures and of appropriate fire safety measures. This article provides an overview of the same, along with a discussion on techniques to evaluate fire resistance rating, the behavior of fire insulation materials, and recent advancements in fire safety technologies for steel structures.



Design of Trusses – An overview

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Summary

The design of trusses involves creating structural frameworks that efficiently support loads by distributing them along their members. This abstract will explore key aspects of truss design, including the types of trusses, material selection, load considerations, and analysis methods. Additionally, it will discuss the importance of factors such as aesthetics, cost-effectiveness, and sustainability in truss design. The abstract will highlight the significance of trusses in various applications, such as bridges, roofs, and industrial structures, and how advancements in technology, computational tools, are influencing truss design. Location of the building is important because different regions have different design codes and requirements based on factors like seismic activity, snow loads, and wind speeds so that structure to withstand. The type of building and slope of roof affects the design load on the building. This paper presents an optimization study aimed at improving the structural efficiency and cost-effectiveness of steel structures, focusing on trusses with varying spans and spacing's. The optimization process considers different parameters such as member sizes, material selection, and connection details to achieve the optimal design for each span and spacing combination. A methodology involving computational analysis and optimization algorithms is employed to determine the most efficient designs. The results demonstrate the significant impact of span and spacing on the optimal design, highlighting the importance of tailored solutions for different structural configurations. This research contributes to the advancement of steel structure design by providing insights into the optimal design of trusses under varying span and spacing conditions, leading to more sustainable and economical structures.

Steel-Concrete Composite Multilevel Car Parks – An economical solution

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Summary

Massive growth in automobiles has put pressure to the availability of horizontal parking space in major cities resulting in an urgent need to find a suitable solution. Thus, multi-level parking lots are essential for the town and city center. The car park keeps cars off the road, easing traffic congestion. ***Unimpeded movement of cars in a large column free arrangement is an important feature of a good car park and steel-concrete composite construction enables large column free designs.*** Also these structures are built in busy commercial areas. There ***the speed of construction being vital factor, composite construction offers an ideal solution.***

The multi-storey car park is a unique style of building; one in which all elements of the structure are normally exposed. Steel with its ability to accommodate longer clear spans and requiring smaller column sizes can create aesthetically pleasing, secure, user-friendly car parks.

The dynamic efficiency of a car park depends on the ease with which entry, exit and parking can be achieved. The general principle should be that car park cover as many stalls as possible on entry and as few as possible on exit. Uncomplicated and logical traffic flow, unimpeded movement of cars, light and airy design and low maintenance are some of the attributes of good car park design. These desirable attributes for good car park will be completely fulfilled if there are no internal columns. Steel-Concrete Composite Construction permits long spans by avoiding internal columns. Hence, multi-level steel intensive car parks offers an ideal parking solution.

To study and identify the optimum structural arrangement, the sloping floor type and split level type arrangements for 5 storied car park to accommodate 572 cars were designed. Overall cost of split-level type was found to be cheaper than the sloping floor type car park.

Institute for Steel Development and Growth (INS DAG) publication – “Handbook on Composite Construction – Multilevel Car Parks” illustrates the design methodology and complete design example for 5 level car park. The results show that the steel concrete composite multilevel car parks not only offer long span construction for easy maneuverability of cars, but also are cost effective.