STRUCTURAL INNOVATION AND ANALYSIS OF AIR CONCOURSE AT RAILWAY STATION

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ABSTRACT.

This Structural Design Basis Report outlines the design and analysis methodologies for the redevelopment of the Bhubaneswar Railway Station, specifically focusing on the Air Concourse structure. The project involves the construction of a steel superstructure, characterized by a deck slab at the concourse level and a tubular roof truss, supported by a robust substructure consisting of reinforced concrete (RCC) pedestals and isolated footings. The design process employs advanced structural analysis software, including STAAD.Pro for the superstructure and SAFE for the substructure, ensuring comprehensive evaluation of both vertical and lateral loads, including seismic and wind forces.

The report details the materials selected for construction, including concrete grades of M30 and M40, high-yield strength deformed bars (Fe500) for reinforcement, and structural steel conforming to IS 2062 standards. The design parameters, including clear cover for fire rating and durability, are established in accordance with relevant Indian codes and standards. Load calculations encompass dead loads, live loads, wind loads, seismic loads, and temperature effects, with appropriate load combinations defined for both strength and serviceability limit states.

This redevelopment project not only aims to enhance the functionality and aesthetic appeal of the railway station but also ensures compliance with safety regulations and sustainability practices. The integration of modern engineering techniques and adherence to established codes positions this project as a benchmark for future infrastructure developments in India.

Keywords : *Infrastructure development, Safe and durable structure, Climate-resilient structure, Sustainable construction practices*

SDG Numbers: 9, 11, 12, 13

I. INTRODUCTION

The primary objective of the redevelopment project for the Bhubaneswar Railway Station is to enhance passenger experience and improve operational efficiency through the construction of a modern Air Concourse. This involves creating a functional, safe, and aesthetically pleasing space that accommodates the needs of travelers. The project incorporates advanced engineering practices and methodologies to ensure structural integrity and safety. Key goals include the segregation of arriving and departing passengers to minimize cross-flows and reduce congestion, and the creation of clear, unobstructed routes from the concourse to the platforms. This is achieved through elevated air passages and clear signage, ensuring a sequenced and linear flow for passengers [1]. The design is based on a thorough understanding of structural design principles, particularly those outlined in Indian Standards, to ensure compliance with safety and performance requirements [2].

II. LITERATURE REVIEW/EXPERIMENTAL DETAILS

A review of relevant literature highlights key areas in modern transit hub design. Studies by Desheng Xua (2024) and Jiaxing Li (2023) emphasize the importance of advanced ventilation systems for smoke control and thermal comfort in large stations. Research by Zihao Chen (2024) and Chunxiang Lin (2022) focuses on passenger thermal comfort and indoor environmental quality, providing insights for balancing comfort with energy efficiency. Furthermore, studies on air quality by Chunhui Li (2023) and Sze Tat Tan (2022) inform the design to mitigate pollution from metal elements and other sources in metro systems.

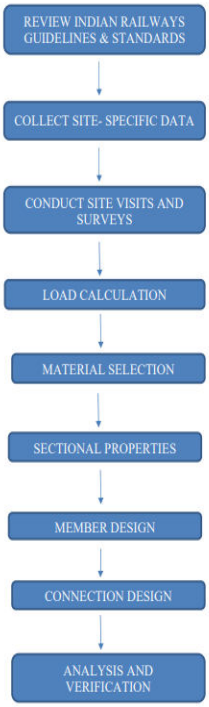
The experimental and design details for the Air Concourse are rooted in established engineering practices. The structure is designed using steel frames with fixed supports at the base, and stability is provided by a moment frame system to resist lateral forces.

Materials Used:

- **Concrete:** Minimum M30 grade for all foundations and M40 for pedestals, conforming to IS 456-2000 [1].
- **Structural Steel:** Hot rolled sections are E350 Grade with a minimum yield stress of 350 MPa (conforming to IS 2062). Hollow sections (RHS/SHS) conform to IS 4923 with a minimum yield strength of 310 MPa [3].
- **Purlins:** Cold-formed Z-sections or C-sections are used, designed according to IS 800:2007 and IS 801:1975 [2, 4].

The design methodology involves using STAAD.Pro for structural analysis to evaluate vertical and lateral loads, including wind and seismic forces calculated as per IS: 875 (Part 3) and IS 1893 respectively [5, 6].

III. METHODOLOGY



IV. RESULT AND DISCUSSION

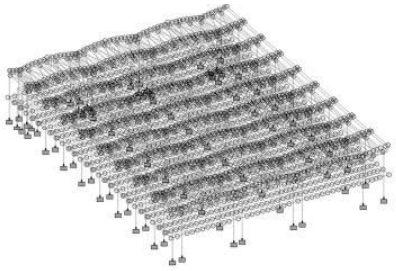


Fig-4: 3d Model View from Stadd Pro.

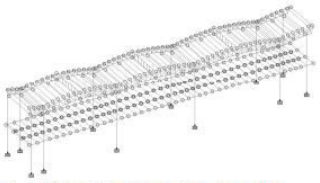


Fig-5: 3d Model View from Stadd Pro for one-Bay

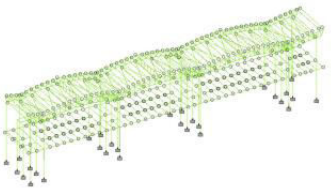


Fig-6: Max Minor Moment on Structure

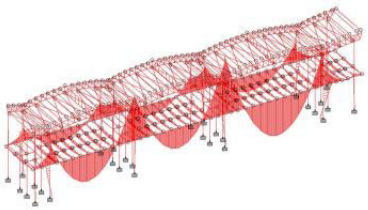


Fig-7: Max Major Moment on Structure

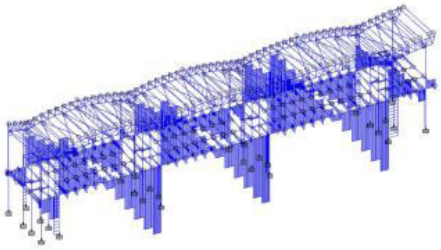


Fig-8: Max Shear Force

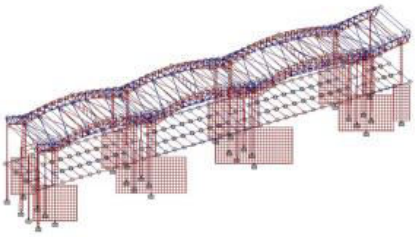


Fig-9: Axial Force

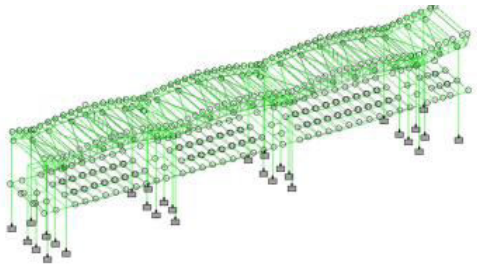


Fig-10: Deflection on the Structure

The analysis of the superstructure was performed using elastic analysis methods within STAAD.Pro, in compliance with the limit state method of IS 800:2007 [2]. The software was used to determine the effects of design actions and to model the internal forces, including maximum bending moments, shear forces, and axial forces on the structure.

A critical aspect of the design was the deflection check under service load combinations. Nodal displacement results from STAAD.Pro were extracted and compared against allowable limits to ensure structural stability, serviceability, and occupant comfort. The maximum vertical deflection at the mid-span of rafters and the lateral sway at the top of columns were monitored to ensure they remained within the permissible limits specified by IS 800:2007, which are typically between span/180 and span/240 depending on the materials and functional requirements [2].

Purlins were designed manually as simply supported beams to support the roof sheeting and transfer loads to the primary rafters. The design calculations accounted for dead load, live load, and wind load (including uplift conditions). The bending strength, shear capacity, and deflection were checked against the requirements of IS 800:2007 to ensure the selected sections were safe, serviceable, and cost-effective [2].

V. CONCLUSION

The redevelopment of the Bhubaneswar Railway Station, specifically the construction of the Air Concourse, successfully integrates modern design principles with advanced engineering practices to meet its core objectives. The project enhances passenger experience by creating a safe, efficient, and comfortable environment. Through the strategic use of high-grade materials and sophisticated structural analysis with STAAD.Pro, the design complies with all relevant Indian Standards for safety and performance. The segregation of passenger flow and creation of clear, accessible routes will significantly improve operational efficiency and reduce congestion. The resulting structure stands as a model for future railway infrastructure projects, balancing functional requirements with modern aesthetics and long-term durability.

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