

"DESIGN AND ANALYSIS OF A DOUBLE STAGE FLYOVER ACCEPTING MULTIPLE LOAD CASES AND DESIGN ISSUES USING SAP2000"

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Abstract

The massive urbanization and vehicular traffic have called for the evolution of intricate transportation infrastructure systems, e.g., double-stage flyovers. The multi-level flyovers offer efficient traffic segregation and enhanced mobility in high-density urban areas where horizontal area is scarce. This study addresses the structural design and analysis of a double-stage flyover using SAP2000, a robust finite element program extensively utilized in civil engineering. The research includes modeling of a two-level flyover structure, comprising reinforced concrete super structures with common and independent substructure elements. The analysis takes into consideration a broad variety of load conditions such as dead loads, live loads (IRC Class AA and 70R), seismic loads (according to IS 1893:2016), wind loads, thermal effects, and vehicular impact loads. Suitable combinations of loads are imposed according to relevant IRC and IS code requirements so as to obtain a safe and serviceable design. Core design issues of differential deflection between stages, mechanisms for load transfer, vertical clearance specifications, and foundation-pier interaction are resolved by the use of sophisticated modeling methods. Response Spectrum Analysis is used to analyze the dynamic characteristics of the structure under seismic excitation, and staged construction analysis is taken into account to capture realistic construction sequences. Results show the structural efficiency and reliability of the designed double-stage flyover under different critical load cases. The research concludes that SAP2000 is a valid means of analyzing and optimizing complicated multi-level flyover systems, providing useful information to engineers and planners of urban infrastructure. The research is part of the increasing literature focused on addressing the problem of urban traffic congestion by innovative structural design

1. INTRODUCTION

Accelerated urbanization and population growth have led to a sharp rise in traffic volume, particularly within cities. The growing need for fast and seamless traffic flow has made it imperative to have improved transportation infrastructure. Double-stage flyover is one such option—a multi-level bridge structure aimed at providing smooth traffic movement at strategic intersections by vertically separating traffic streams. This type of grade separation not only reduces congestion but also maximizes the use of land in high-density urban settings. Traditional single-level flyovers usually lack in dealing with the nuances of multi-directional and high-density traffic. A double-stage flyover, however, involves two independent levels of carriageways on a common or partially shared substructure. This method brings forth peculiar structural challenges, including augmented load requirements, seismic susceptibility, interaction forces between phases, and intricate staging of construction. Structural design and analysis of this type of system need sophisticated

modeling techniques that can replicate actual behavior under various loading conditions. In the present research, SAP2000, a robust finite element analysis software tool, is utilized to simulate and analyze a two-level flyover structure. The flyover is constructed by reinforced concrete box girders and piers, keeping in mind various load conditions such as dead load, live load (IRC Class AA and 70R), seismic loads (IS 1893:2016), wind, temperature, and braking forces of vehicles.

The aim of this study is to examine the structural behavior of a double-stage flyover by using detailed modeling, analysis, and design verification. The research focuses on the determination of important stress zones, analysis of deflection and displacement characteristics, determination of the influence of load combinations, and satisfaction of applicable Indian standards. Moreover, the study delves into applied design issues like vertical clearance, foundation design, and construction sequencing. This paper adds to the body of knowledge in transportation infrastructure by proposing a systematic approach to the structural design and analysis of intricate multi-level flyover systems, providing insights useful for engineers, designers, and urban planners concerned with the development of sustainable urban mobility options.

1.1. Necessity For The Project

Urban cities are experiencing acute traffic congestion as a result of urban population growth and restrained road space. Conventional traffic solutions, such as single-level flyovers, are no longer adequate for busy intersections. Double-stage flyover offers an efficient method to divert traffic vertically, enhancing flow and minimizing delays without the need for extra land.

Such structures, however, bring forth sophisticated design issues such as added loads, seismic susceptibility, and constructional difficulties. For structural efficiency and safety, the use of advanced analysis with tools such as SAP2000 is necessary. The project responds to the critical necessity for innovative, space-savvy, and technically viable solutions for urban traffic control.

1.2. Objectives:

- To investigate high traffic density requirements of a flyover bridge
- To examine essentials for seamless industrial and agriculture good movement
- To reduce the traffic delay and propose flyover with good ethics and architectural outlook.

2. LITERATURE SURVEY

In this paper the research addresses the issues which arise in high traffic region in Trichy. The study affects traffic behavior of both the structural elements of highway and flyover bridge systems. In addition, it is also illustrated that has positive impact on the superstructure response and at times create unwanted effects on the system behavior and depends on the nature of the high volume of vehicle movement intensity. In my case here, I take the location to be between Trichy to Chennai Highway since there are more traffic issues particularly during peak hours. It is an overpass and underpass combined form a grade separation. Stack interchanges consist of numerous over passes. For Pedestrians cross over busy road without affecting traffic. Survey is a research methodology employed for gathering data from various sources in order to carry out the project effectively. To carry out the project, I have carried out survey to gather the density of traffic flow and to find out the density of traffic flow in moments of time. Here by me I have surveyed for density of vehicles at on at various intervals of time to get proper results at that specific junction. I have also seen that there are various types of vehicles passing through on at various moments of time. There is difference in vehicles that. Pass through this junction, I here have recorded the density of traffic follow which passes through

[1].Paper name:- Analysis of flyover structures with various loads M. Alla Rangaswamy, International Journal of Engineering Sciences & Research Technology, and March 2022

Author name :- M.Alla Rangaswamy

Description:- It takes time to construct flyover design, construction, and installation traffic easing devices. ONGOLE's 600m-long, 6.6m-wide flyover also has the same. Higher cost of flyover is offset by seismic durability, lifetime, and life cycle cost savings. Bridges and fly-overs don't have roadblocks. Road, railroad, or valley route is what this is. Creativity, practicability, safety, and economy are needed in bridge design. A structure should be constructed to withstand all anticipated use during its lifespan. The structure must be durable. Congested traffic requires flyovers or over bridges. We are designing a flyover. Four motorways intersect at a pipeline, producing traffic issues

[2].Paper name:- Design of Flyover Construction using Fibre Reinforced Concrete and Timber Pile Foundation J Prakash Arul Jose, International Journal of Applied Engineering Research, 2022

Author name :- J.Prakash Arul Jose

Description:- The project is one of a kind among other construction systems in which the deck and pile foundations consist of huge timber concrete vertical support through earth matters up-to the rock layers. The superstructure's girders are constructed from fibre reinforced concrete. The design, right from its inception until its completion, is depicted with requisite diagrams. The construction is subjected to a series of tests to ascertain its stability and durability.

[3].Paper name:- Analysis and Design of Skew Flyovers Nikhil V. Deshmukh, International Journal of Science and Research (IJSR) 2018

Author name :- Nikhil V. Deshmukh

Description:- Flyovers are extremely unique type of structures. They are distinguished by their simplicity in geometry and load conditions. The Flyovers of reinforced concrete used to carry uniformly distributed dead load, vehicular live load to its surface and transfer same to the support through flexure, shear and torsion. Newly constructed Flyovers are frequently skew. This is because space limitations in dense urban environments. It can also be required because of geographical reasons like mountainous areas. But force flow in skew Flyovers is far more complex than straight Flyovers. Hence thorough study and numerical analysis must be done, where a skew Flyovers can be modelled in a variety of ways. Distorted slab Flyovers were analyzed with finite-element techniques with Csi Flyover computer software to investigate their behavior under uniform and moving loads with in order to ascertain the most suitable force response for design.

3. RESEARCH OF METHODOLOGY

This research adopts a systematic method for modeling, analyzing, and assessing the structural behavior of a double-stage flyover under loads of different nature using SAP2000. The adopted methodology for the research includes the following major steps:

3.1 Data Collection and Preliminary Planning

Choice of representative urban site with common traffic loads. Choice of span length, carriageway widths, number of levels, pier heights, and support conditions from standard flyover configurations. Use of applicable design codes like IRC 6, IRC 112, IS 456:2000, and IS 1893:2016 for load requirements and design specifications.

3.2 Modeling in SAP2000

Generation of a 3D finite element model for the double-stage flyover. Declaration of material properties (M40 concrete, Fe500 steel). Allocation of cross-sectional properties for box girders, piers, and substructure elements. Utilization of shell elements for deck slabs and frame elements for girders and piers. Incorporating boundary conditions (fixed and spring supports for piers and foundations).

3.3 Load Application

- Loading of various load cases according to Indian standards:
- Dead Load: Self-weight, parapets, wearing coat.
- Live Load: IRC Class AA and Class 70R vehicle loading.
- Seismic Load: According to IS 1893:2016 by Response Spectrum Analysis.
- Wind Load: According to IS 875 Part 3.
- Temperature Effects and Braking/Impact Loads.

3.4 Structural Analysis

Conduction of Linear Static Analysis and Response Spectrum Analysis.

Assessment of important structural responses like:

- Bending moments
- Shear forces
- Axial forces
- Deflections
- Support reactions
- Location of maximum stress points and possible design issues.

3.5 Design Checks

- Checking of structural members for:
- Ultimate load capacity
- Serviceability limits (deflection, vibration, crack width)
- Reinforcement detailing according to IRC 112 and IS 456
- Foundation check for design based on pier load reactions.

3.6 Interpretation and Documentation

- Tabulation of results of analysis and interpretation of structural behavior.
- Comments on design complexities and recommendations for double-stage flyover schemes.
- Preparation of detailed design documentation, drawings, and conclusions.

4.RESULTS:-

I-Girder of Double Decker Auto-Seismic IS-1893:2016

TABLE: AUTO SEISMIC - IS1893:2016					
Load Patterns	Directions	Z-Code	Soil Type	I	R
Text	Text	Text	Text	Unit less	Unit less
EX	X	0.10	II	1	5
EY	X	0.10	II	1	5

U-Girder of Double Decker Auto-Seismic IS-1893:2016

TABLE: AUTO SEISMIC - IS1893:2016						
Load Patterns	Directions	Ct	Z-Code	Soil Type	I	R
Text	Text	Unit less	Text	Text	Unit less	Unit less
EQX	X	0.075	0.10	II	1	5
EQY	X	0.075	0.10	II	1	5

5.ACKNOWLEDGEMENT:-

I would like to thank all the people who have inspired and guided me through the successful completion of this project on the Analysis and Design of a Double-Stage Flyover with the help of SAP2000. I am first immensely thankful to Marathwada Mitra Mandal Institute Of Technology, Lohgaon and the Department of Civil Engineering for the generous kindness of providing me the opportunity and resources to carry out this project. I would like to thank my project guide, Prof.M.P.Pawar, whose professional guidance, fruitful suggestions, and continuous motivation were instrumental in shaping this work. My thanks to the faculty and staff members of the Civil Engineering department for their valuable suggestions, technical input, and encouragement throughout the course of this project.

I owe thanks to the SAP2000 developers, with their high-end structural analysis and design capabilities, for enabling it to perform the intricate modeling and analysis needed in a double-stage flyover structure. Finally, I thank my family and friends for the constant support, who were patient and motivated me to stay determined and focused on achieving the aim of this project.

6.REFERENCES:-

- [1]. Review of annual progress of Flyover engineering in 2019, Renda Zhao, Yuan Yuan,
- [2]. Seismic performance of precast Flyover columns connected with grouted corrugated-metal duct through biaxial quasi-static experiment and modeling, Xia Zhanghua, Lin Shangshun, 16 July 2021
- [3]. Girder Longitudinal Movement and Its Factors of Suspension Flyover under Vehicle Load Guoping Huang, Research Article, 1 October 2021
- [4]. Dynamic Behaviour of Flyover Girders with Trapezoidal Profiled Webs Subjected to Moving Loads, Zhiyu Wang, Yunzhong Shi, MDPI 2021
- [5]. ANALYSIS FOR EARTHQUAKE-RESISTANT OF FLYOVER STRUCTURE SUBJECTED TWO EARTHQUAKES, LIU Chunguang, MDPI 2021
- [6]. Comparative Analysis and Design of Steel Foot Flyover using Conventional and Hollow Section Anushka

- M.Pachpute, Nikita J.Patil, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Elsevier 2020
- [7]. Numerical Examination of Reinforced Concrete Skew Slabs Boobalan S C, Abirami P, Indhu K, International Journal of Innovative Technology and Exploring Engineering (IJITEE), March 2021
- [8]. Design and Analysis of Flyover, Bismi M Buhari International Journal of Engineering Research & Technology (IJERT), July-2021
- [9]. Comparative Study of Grillage Analogy and Finite Element Method for Flyover Heavy Load Assessment, Shojaeddin Jamal, Tommy H.T. Chan
- [10]. Analysis and Design of Foot Flyover Connecting (2nd Floors) of Block A and Block B of MIET, Jammu Akhil Sharma, Ashwani Kumar, Sunil Sharma, Arun Singh Chib, International Journal of Engineering Research & Technology (IJERT), May-2020

