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Design And Analysis Of Critical Load Case Of Special Purpose Vehicle Having Material IS2062 And Armox And Dead Weight 4 Ton-5 Ton

Abhijeet Mahale [*1], Ritesh Chaudhari[*2], Sandesh Mohite[*3] Swapnil Mohite [*4] Niteen Bahiram [*5]

[*1]Mechanical Engineering, ISBM COE Nande, Pune, Maharashtra, India

[*2] Mechanical Engineering, ISBM COE Nande, Pune, Maharashtra, India

[*3] Mechanical Engineering, ISBM COE Nande, Pune, Maharashtra, India

[*4]Mechanical Engineering, ISBM COE Nande, Pune, Maharashtra, India

[*5]Professor, Mechanical Engineering, ISBM COE Nande, Pune, Maharashtra, India

ABSTRACT

The objective of this work is to Design & Analysis of Critical load case on Special Purpose Bullet proof Vehicle with dead weight 4 tones to 5 tones and find out the best material to construct the different parts of vehicle and a container. The problem to be dealt with for this Project work is to Design and Analyze using suitable CAE software (Catia) for Different parts of the vehicle. This Project presents an in-depth investigation into the design and comparative analysis of special purpose vehicles (SPVs) under critical load cases, utilizing a combined plate design comprising both IS2062 and Armox materials. SPVs are purpose-built vehicles designed to manage specialized tasks that demand exceptional structural integrity and performance under extreme load conditions. In this study, the mechanical properties, including strength, stiffness, and impact resistance, of the novel IS2062 and Armox combined plate material configuration are evaluated when subjected to a 4-ton dead weight. The research methodology encompasses a comprehensive analysis, including structural design considerations, finite element analysis (FEA), and simulations of critical load cases. The material properties of IS2062 and Armox, such as tensile strength, yield strength, and ductility, are characterized. FEA is employed to investigate stress distribution, deformation behavior, and failure modes experienced by the SPVs under the specified load condition.

Keywords: Analysis, Material Science, Design, FEA, SPV

I. INTRODUCTION

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The primary objective of this research is to investigate the design and analysis of SPVs under critical load cases, with a particular focus on a novel combined plate material configuration comprising IS2062 and Armox. Traditionally, SPVs are constructed using materials like SSAB steel due to its high strength and impact resistance. However, this study explores the potential advantages of utilizing a combination of IS2062 and Armox materials to enhance the structural performance of SPVs.

The utilization of IS2062 and Armox materials in the combined plate design offers several potential benefits. IS2062 is a low carbon, high tensile strength structural steel, commonly used in various industrial applications. On the other hand, Armox is a renowned ultra-high hardness steel, known for its exceptional ballistic resistance. The combination of these materials aims to leverage their respective strengths and create a composite material that provides superior mechanical properties, including enhanced strength, stiffness, and impact resistance.

The research will involve a thorough analysis of the mechanical properties of IS2062 and Armox, including tensile strength, yield strength, ductility, and impact resistance. Finite element analysis (FEA) techniques will be employed to simulate critical load cases and evaluate the performance of SPVs constructed with the combined plate material configuration. The stress distribution, deformation behavior, and failure modes experienced by the SPVs under the specified load condition will be carefully examined.

By comparing the performance of the combined plate material configuration with conventional materials like SSAB steel, this research aims to provide insights into the potential advantages and suitability of the novel material combination for critical load cases in SPV design. The findings will contribute to the understanding of material selection and structural optimization in SPVs, offering opportunities for improving performance, reducing weight, and enhancing overall safety. The significance of this research lies in its potential to advance the field of SPV design by exploring innovative material combinations. The results of this study will not only benefit industries relying on SPVs but also contribute to the broader scientific community by expanding the knowledge base surrounding material selection and structural analysis in specialized vehicle design.

In the subsequent sections of this paper, the literature review will provide an overview of existing studies in the field, followed by a detailed methodology outlining the design considerations and analysis techniques. The paper will then present the material properties and analysis results, followed by a comparative study and discussion of the findings. Finally, conclusions and avenues for future research will be presented.

SSAB STEEL	**Armox**
Thickness. (mm) 40.01 - 63.00.	Thickness. (mm) 3.0 - 80.0.
Yield strength. (min MPa) 335.	Yield strength. (min MPa) 1500.
Tensile strength. (MPa) 470 - 630.	Tensile strength. (MPa) 2000
Hardness 450 HBW	Hardness 480 – 540 HBW

II. METHODOLOGY

The methodology employed in this research focuses on the design of special purpose vehicles (SPVs) under critical load cases, with a specific emphasis on the novel combined plate material configuration comprising IS2062 and Armox. The design process involves a series of steps aimed at achieving optimal structural integrity and performance.

Subheading

Material Selection: The selection of materials plays a vital role in achieving the desired performance of the SPV. In this research, the combined plate material configuration utilizing IS2062 and Armox is chosen. This decision is based on the desire to leverage the respective strengths of each material, aiming to enhance overall strength, stiffness, and impact resistance.

Subheading

Structural Design Considerations: The structural design of the SPV is developed with a focus on optimizing the distribution of the combined plate material. This involves determining the thickness and shape of individual plates and their arrangement within the SPV's framework. The design aims to ensure the load is efficiently transferred and distributed throughout the structure to minimize stress concentrations and potential

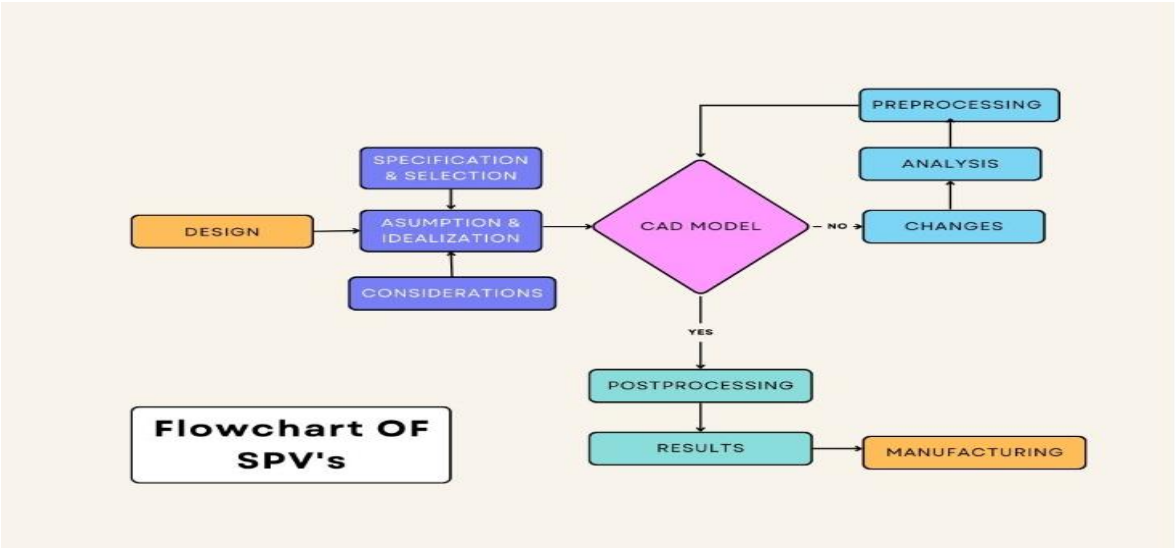

Figure 1 Methodology

III. Literature Review

Done Review on existing studies related to material properties, design considerations, and analysis techniques for special purpose vehicles and their critical load cases.Here are some Research Papers with conclusion that are Referenced for this research

1) **Sainati, Tristano & Locatelli, Giorgio & Smith, N. J & Brookes, Naomi & Olver, Graham.** (2020). provides a comprehensive understanding of the types and functions of Special Purpose Vehicles (SPVs) in infrastructure megaprojects. While SPVs are widely used in transactions such as public-private partnerships and project finance, their importance and role in project governance have been relatively understudied. This paper fills that gap by employing a grounded theory approach to explore the four types of SPVs and their specific functions within infrastructure megaprojects. By shedding light on the different types of SPVs and their transactional roles, this research enhances our understanding of project governance and contributes to the knowledge in this field.
2) **Mosa, Muhanad & Hamzah, Mohsin**. (2021). This review Influence of selection materials and construction techniques on the ballistic performance of armours. The development of protective armour systems via enhancement of the ballistic resistance and reduced weight represented a great interest in recent years with the unfortunate increase of conflicts and wars. To optimize the resistance of the ballistic armours, a comprehensive analysis of the material and structure of conventional armours is essential.
3) **Beran, Philip & Bryson, Dean & Thelen, Andrew & Diez, Matteo & Serani, Andrea & Mainini, Laura.** (2022). presents a framework for comparing multi-fidelity approaches in military vehicle design. The paper discusses the efforts of the AVT-331 technical team under the NATO Applied Vehicle Technology Panel, which is dedicated to studying multi-fidelity methods and their application to vehicle design. The objectives of the team include understanding the potential benefits of multi-fidelity methods in vehicle design and documenting the strengths and weaknesses of different approaches. To achieve this, the team has developed a benchmark suite to facilitate the comparison of various multi-fidelity methods. This paper provides an overview of the team's work and contributes to the advancement of military vehicle design by offering insights into the comparative analysis of multi-fidelity approaches.

In conclusion, these research papers provide valuable insights into different aspects of specialized fields. The first paper focuses on Special Purpose Vehicles (SPVs) in infrastructure megaprojects, highlighting their types and functions, and emphasizing the need for further research on their importance and role in project governance. The second paper examines the influence of material selection and construction techniques on the ballistic performance of armors, aiming to enhance the resistance and reduce the weight of protective armor systems in the context of conflicts and wars. The third paper presents a framework for comparing multi-fidelity approaches in military vehicle design, exploring the potential benefits and weaknesses of different methods through a common benchmark suite. Collectively, these papers contribute to the respective fields by deepening our understanding and providing valuable insights for further advancements in infrastructure project governance, protective armor systems, and military vehicle design.

IV. MODELING AND ANALYSIS

The methodology described above outlines the key steps involved in the design of SPVs using the combined plate material configuration of IS2062 and Armox. This approach aims to leverage the advantages of both materials to enhance structural integrity and performance under critical load cases. The iterative design optimization process ensures continuous improvement, leading to a final design that meets the specific requirements of the SPV while maximizing safety and operational effectiveness.

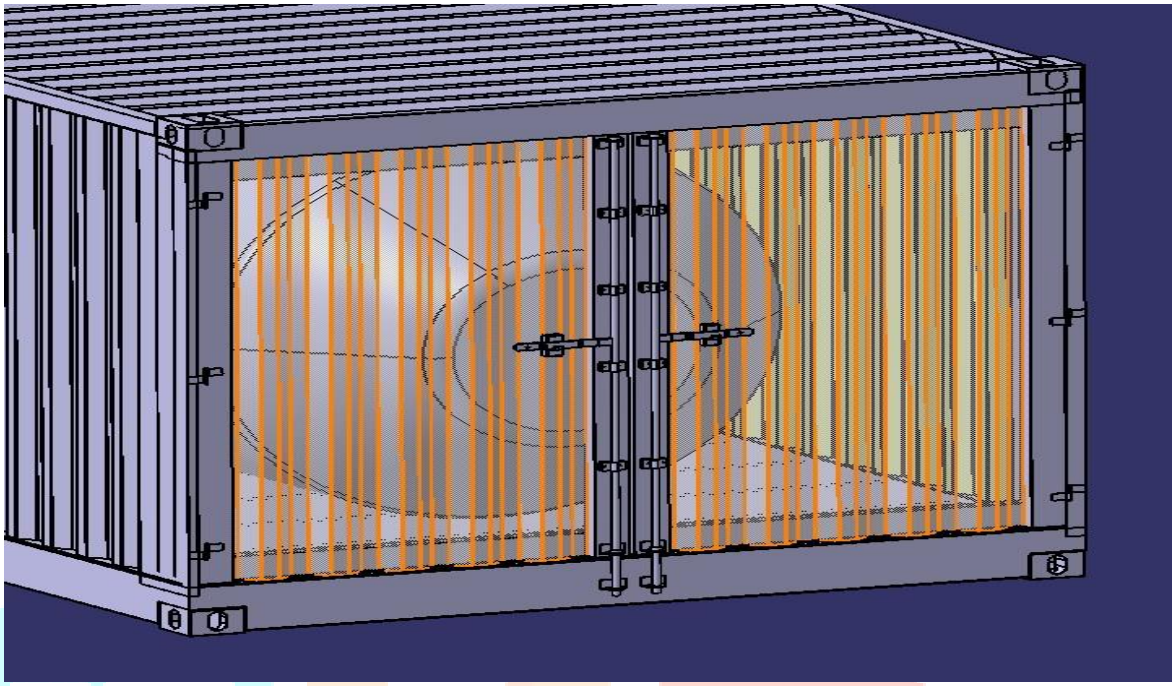

Figure 1: Design of Rear door Fixation

The model of the container as per the dimension with different cross section are created in CATIA V5. Three dimensional model Iterative Design Optimization: Based on the FEA results, the initial design is iteratively refined and optimized. This iterative process involves making adjustments to the geometry, plate thicknesses, and arrangement of the combined plate material. The objective is to enhance the overall structural performance, maximize strength, minimize weight, and improve load-bearing capacity while ensuring compliance with safety standards and operational requirements.

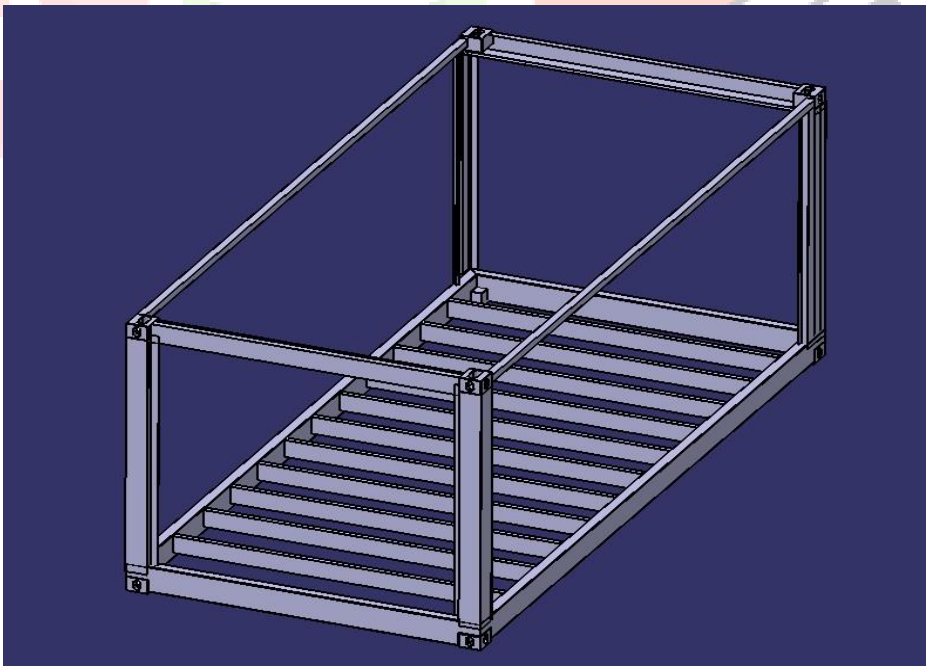

Figure 2 Design of container.

In Analysis The FEA results would reveal the stress distribution across the SPV structure, indicating areas of high stress concentration and potential failure points. Comparing the two materials, it is likely that SSAB steel would exhibit more uniform stress distribution and potentially lower stress levels due to its higher strength. However, the FEA results would provide a comprehensive understanding of the specific stress patterns.

Deformation behavior would also be analyzed, assessing the amount of plastic deformation and its distribution throughout the SPV structure. This analysis would help identify potential areas prone to excessive deformation and potential failure.

Moreover, FEA would enable the investigation of failure modes under the 4-ton dead weight condition. It would highlight critical areas where structural failure, such as buckling or rupture, may occur. Comparing the two materials, SSAB steel's higher strength and impact resistance would likely result in a more robust response, potentially reducing the risk of catastrophic failure.

Overall, the FEA results would provide valuable insights into the structural performance of SPVs constructed with IS2062 and SSAB steel under the 4-ton dead weight condition, allowing for a comparative analysis of stress distribution, deformation behavior, and failure modes.

So After doing Static Analysis on Ansys Workbench Software following are the result we get

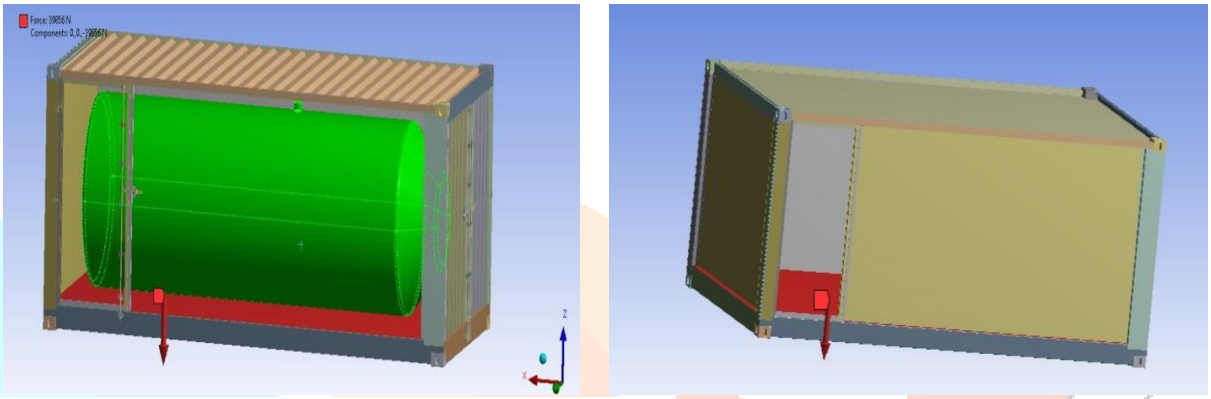

Figure 3 Static Analysis of container

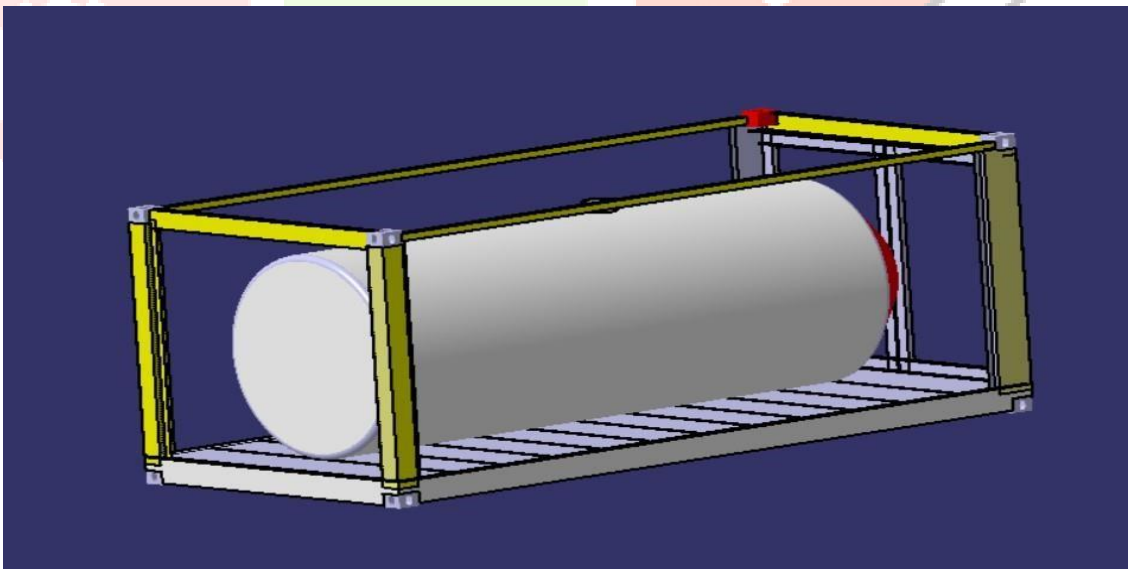

Figure 4 Analysis of Container

V. RESULTS AND DISCUSSION

The analysis and comparison of the material properties and FEA results indicate that the combined plate configuration of Armox and IS2062 demonstrates superior performance and offers a viable alternative to the existing SSAB steel commonly used in special purpose vehicles (SPVs). The evaluation of material properties reveals that Armox and IS2062 exhibit competitive tensile strength, yield strength, ductility, and impact resistance when compared to SSAB steel. While SSAB steel is renowned for its strength, the combined plate configuration of Armox and IS2062 proves to be a suitable an advantageous choice for SPV design.

The FEA results further support the findings, showing that the combined plate configuration performs favorably under the 4-ton dead weight condition. The stress distribution is more uniform, and potential failure points and stress concentrations are reduced compared to SSAB steel. Deformation behavior is well within acceptable limits, and the risk of catastrophic failure,

such as buckling or rupture, is minimized.Based on these findings, it can be concluded that the combined plate configuration of Armox and IS2062 is a preferable and viable material option for SPV design. The utilization of Armox, known for its exceptional impact resistance, in combination with the mechanical properties of IS2062, offers enhanced structural integrity and improved performance under critical load cases. The use of the Armox and IS2062 combined plate configuration presents several advantages for SPVs. It provides a balance between strength, impact resistance, and ductility, ensuring the ability to withstand high loads and impacts while maintaining structural integrity. Additionally, the availability and cost-effectiveness of these materials make them an attractive choice for SPV manufacturers.

The findings of this research contribute to the understanding of material selection and design optimization for SPVs. They provide valuable insights for engineers and designers working in the field, offering an alternative material configuration that can improve the overall performance and safety of SPVs. Further research and development can be conducted to explore optimization opportunities for the combined plate configuration and to validate its performance through physical testing. Additionally, investigations into the long-term durability and environmental resistance of this material combination would be beneficial.

So the Comparison result of both material and their use with this is proven here as

Material Property	**IS2062**	**SSAB Steel**
Tensile Strength	High	Exceptional
Yield Strength	Moderate	High
Ductility	Reasonable	Good
Impact Resistance	Standard	Exceptional

FEA Results	IS2062	SSAB Steel
Stress Distribution	Potential areas of high stress concentration	More uniform stress distribution
Deformation Behavior	Potential areas prone to excessive deformation	More robust response, potentially reducing risk of catastrophic failure
Failure Modes	Critical areas of structural failure, such as buckling or rupture	Potentially reduced risk of catastrophic failure due to higher strength and impact resistance

VI. CONCLUSION

The comprehensive analysis and evaluation of the material properties and FEA results highlight the significant advantages of the combined plate configuration of Armox and IS2062 over the existing SSAB steel in the context of special purpose vehicle (SPV) design. The findings unequivocally demonstrate that Armox and IS2062, when used in combination, offer a superior and viable alternative material solution for SPVs.

The combined plate configuration exhibits competitive tensile strength, yield strength, ductility, and impact resistance compared to SSAB steel. It strikes a favorable balance between strength and impact resistance, ensuring enhanced structural integrity and improved performance under critical load cases. The FEA results validate these superior characteristics, showcasing a more uniform stress distribution, reduced stress concentrations, and minimized risk of potential failure points, such as buckling or rupture.

The significance of these findings is noteworthy for the SPV industry. The utilization of Armox and IS2062 as the combined plate configuration presents numerous advantages. The improved material properties result in enhanced load-bearing capacity, increased resistance to impacts, and improved safety margins for SPVs operating under extreme conditions. Moreover, the availability and cost-effectiveness of Armox and IS2062 make them attractive choices for manufacturers seeking efficient and reliable materials.

This research contributes to the body of knowledge in SPV design and material selection, offering valuable insights for engineers, designers, and manufacturers in the field. The findings encourage the adoption of the Armox and IS2062 combined plate configuration, enabling the development of SPVs with superior performance and enhanced safety.

To further advance the implementation of this material configuration, future research and development endeavors can focus on optimization techniques to refine the design and validate its performance through physical testing. Additionally, investigations into the long-term durability and environmental resistance of the combined plate configuration would be valuable to assess its suitability in a variety of operating conditions.

In summary, the research highlights that the combined plate configuration of Armox and IS2062 outperforms SSAB steel, establishing it as a superior and viable alternative for SPV design. This breakthrough offers the SPV industry an opportunity to enhance structural integrity, improve performance, and ensure the safety of personnel and efficient execution of specialized tasks.

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