

“Comparative Cost Analysis of SuperArch Bridge and PowerArch Bridge”

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Abstract - Cost-effective bridge selection remains a critical challenge in infrastructure development, particularly for rural and medium-span crossings. This study presents a comparative cost analysis of SuperArch and PowerArch bridge systems using a practical engineering approach based on General Arrangement Drawings (GAD) and Maharashtra PWD Schedule of Rates (SSR). Three span configurations for each system were analysed through detailed quantity take-off and Excel-based estimation.

The results demonstrate that SuperArch bridges achieve approximately 7-10% lower construction cost compared to PowerArch bridges for similar bridge lengths. This reduction is primarily attributed to minimization of substructure components and elimination of reinforcement steel. In contrast, PowerArch bridges provide greater span capability and modular construction advantages, but incur higher initial costs due to advanced materials such as HDPE pipes, GFRP reinforcement, and Self-Compacting Concrete (SCC).

The study identifies span optimization and substructure reduction as the dominant factors governing bridge cost, providing a practical framework for engineers to select suitable bridge systems under real field conditions.

Key Words: SuperArch, PowerArch, Cost Analysis, GAD, SSR, Bridge Estimation, Arch Bridge, Infrastructure Economics

1. INTRODUCTION

Bridges form the backbone of transportation networks, enabling connectivity, trade, and regional development. However, conventional reinforced concrete (RCC) bridges often involve high construction cost, significant material consumption, and long-term maintenance challenges due to corrosion.

To address these limitations, modern arch-based systems such as SuperArch and PowerArch bridges have been introduced. These systems utilize compression-dominated structural behavior, reducing dependence on steel reinforcement and improving durability.

- SuperArch bridges employ precast concrete blocks forming a compression arch system.
- PowerArch bridges utilize HDPE pipes, GFRP reinforcement, and SCC, enabling modular construction and larger span capability.

Despite their growing use, cost-based comparative studies using practical estimation methods remain limited. This research bridges that gap by providing a data-driven, GAD-based cost comparison, making the results directly applicable to engineering practice.

2. LITERATURE REVIEW

Recent advancements in bridge engineering have emphasized the development of economical, durable, and efficient structural systems, particularly for rural and medium-span applications. Bridge selection is influenced by several factors including span length, material availability, construction methodology, and overall cost efficiency. Studies on life-cycle cost analysis highlight that bridge evaluation should consider not only initial construction cost but also maintenance, repair, and user-related costs, ensuring long-term sustainability.

Traditional bridge systems such as RCC, PSC, and steel structures have been widely studied for cost comparison. It has been observed that RCC bridges are economical for short spans, while prestressed concrete and steel systems are more suitable for medium to long spans, depending on site conditions and construction constraints. However, these systems often involve higher maintenance requirements and longer construction durations.

Arch bridges, one of the oldest structural forms, are known for their efficient load transfer through compression, resulting in high durability and long service life. Research indicates that arch bridges provide a balance between structural efficiency and aesthetic value, although they may involve relatively complex construction methods.

In recent years, innovative arch bridge systems such as SuperArch and PowerArch bridges have gained attention. The SuperArch system utilizes precast concrete blocks arranged in a compression arch configuration, eliminating the need for reinforcement steel. This significantly reduces corrosion-related issues, construction time, and maintenance requirements, while providing a service life exceeding 100 years. Studies also highlight its suitability for rehabilitation and widening of existing bridges, making it a cost-effective alternative to conventional systems.

On the other hand, PowerArch bridges represent a modern approach to accelerated bridge construction (ABC). These systems incorporate advanced materials such as High-Density Polyethylene (HDPE) pipes, Glass Fiber Reinforced Polymer (GFRP) bars, and Self-Compacting Concrete (SCC). Literature indicates that PowerArch bridges offer rapid construction, improved durability, and adaptability for larger spans, with successful implementation in prototype projects completed within short durations. Experimental studies further

confirm their high load-carrying capacity and structural reliability.

Despite these advancements, most existing research focuses primarily on structural behaviour, material performance, and construction techniques, with limited emphasis on practical cost comparison using real estimation methods. There is a lack of studies integrating General Arrangement Drawings (GAD), quantity take-off, and Schedule of Rates (SSR) for evaluating economic feasibility.

There is a need for a practical, data-driven comparative cost analysis of SuperArch and PowerArch bridge systems using real project estimation techniques.

This study provides a practical and engineering-oriented cost comparison framework, bridging the gap between theoretical research and real-world bridge construction practices.

3. METHODOLOGY

3.1 Study Framework

The methodology is based on a practical and systematic workflow:

GAD → Quantity Take-off → SSR Rates → Cost Calculation → Comparative Analysis.

3.2 Bridge Configurations

SuperArch Bridges

- Span: 14.94 m, Rise: 4.90 m
- Span: 23.95 m, Rise: 5.60 m
- Span: 31.67 m, Rise: 7.84 m

PowerArch Bridges

- Span: 47.00 m, Rise: 7.83 m
- Span: 40.00 m, Rise: 7.79 m
- Span: 30.30 m, Rise: 6.08 m

3.3 Data and Tools

AutoCAD → Preparation of GAD

Excel → Quantity estimation and cost analysis

Maharashtra PWD SSR → Rate analysis

4. RESULTS AND ANALYSIS

4.1 SuperArch Bridge Results

Trial	Length (m)	Cost (₹ Cr)
T1	99.86	6.56
T2	102.78	5.31
T3	100.06	5.23

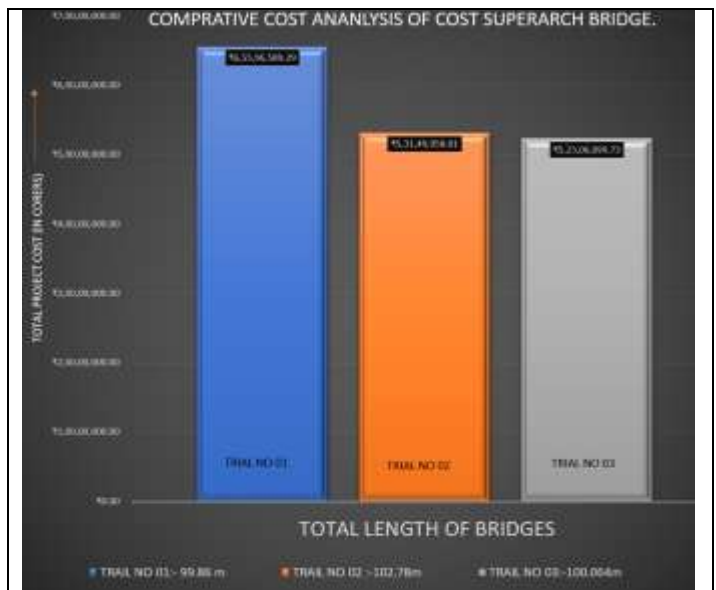


Fig. 1: SuperArch Cost vs Trial

A clear reduction in cost is observed with span optimization. The decrease in the number of piers results in **significant reduction in foundation and substructure cost.**

4.2 PowerArch Bridge Results

Trial	Length (m)	Cost (₹ Cr)
T1	103.14	7.92
T2	87.93	6.45
T3	98.32	5.63



Fig. 2: PowerArch Cost vs Trial

Although cost reduces in optimized configurations, PowerArch remains costlier due to **high-cost arch system and advanced materials.**

4.3 Comparative Cost Analysis

Bridge Type	Minimum Cost (₹ Cr)
SuperArch	5.23
PowerArch	5.63

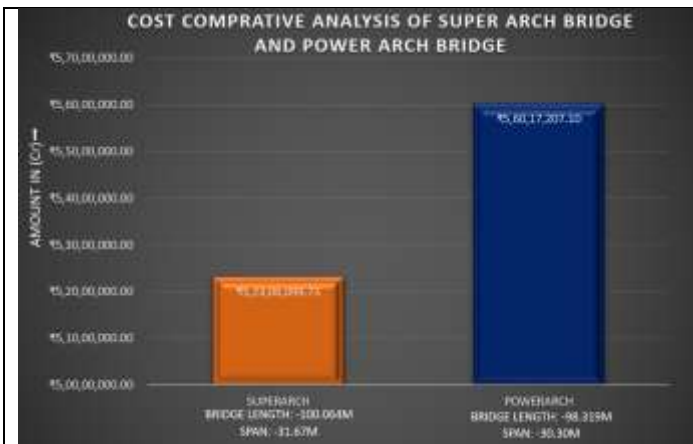


Fig. 3: SuperArch vs PowerArch.

Result: SuperArch is approximately 7–10% more economical.

3.4 Cost Efficiency (Cost per Meter)

System	Cost (₹ L/m)
SuperArch	~5.2
PowerArch	~5.7

SuperArch provides better cost efficiency per unit length, confirming its suitability for budget-constrained projects.

3.5 Component-Level Cost Behaviour

- **Abutment & Pier:** Major cost contributor in SuperArch

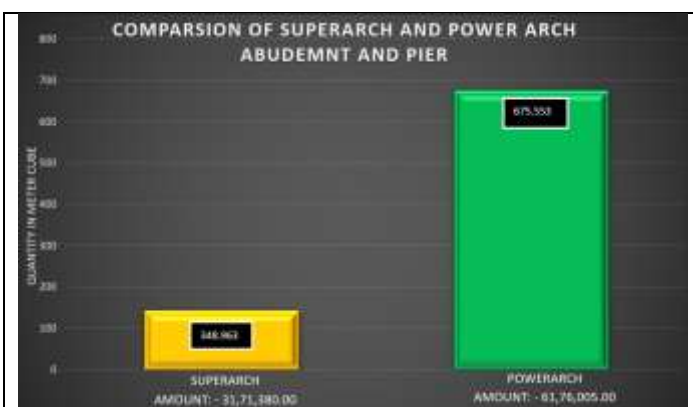


Fig. 4: Abutment & Pier

- **Haunch Filling:** Increases with span



Fig. 5: Haunch Filling

- **Precast Blocks & Lifting:** Moderate cost contribution
- **PowerArch Arch Ring:** Dominant (~40% of total cost)

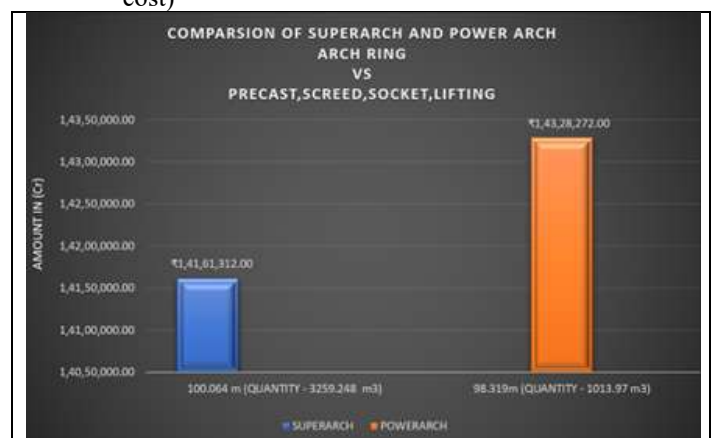


Fig. 6: Precast Blocks & Lifting vs PowerArch Arch Ring

3. CONCLUSIONS

This study presents a GAD-based comparative cost analysis of SuperArch and PowerArch bridge systems using SSR rates. The results show that the SuperArch bridge achieves a minimum cost of ₹5.23 Cr, which is approximately 7–10% lower than the PowerArch bridge (₹5.63 Cr) for comparable spans.

The analysis clearly indicates that substructure components (abutments, piers, and foundation) are the dominant contributors to total cost. Reduction in the number of piers through span optimization leads to significant savings in excavation and concrete, making it the most effective strategy for cost reduction.

Although the PowerArch system offers advantages such as larger span capability and modular construction, its cost is higher due to the arch ring system and use of advanced materials.

- **SuperArch** → Best for economical, medium-span bridges
- **PowerArch** → Suitable for larger spans and advanced construction needs

This study provides a practical and field-oriented framework for selecting cost-efficient bridge systems using GAD and SSR-based estimation.

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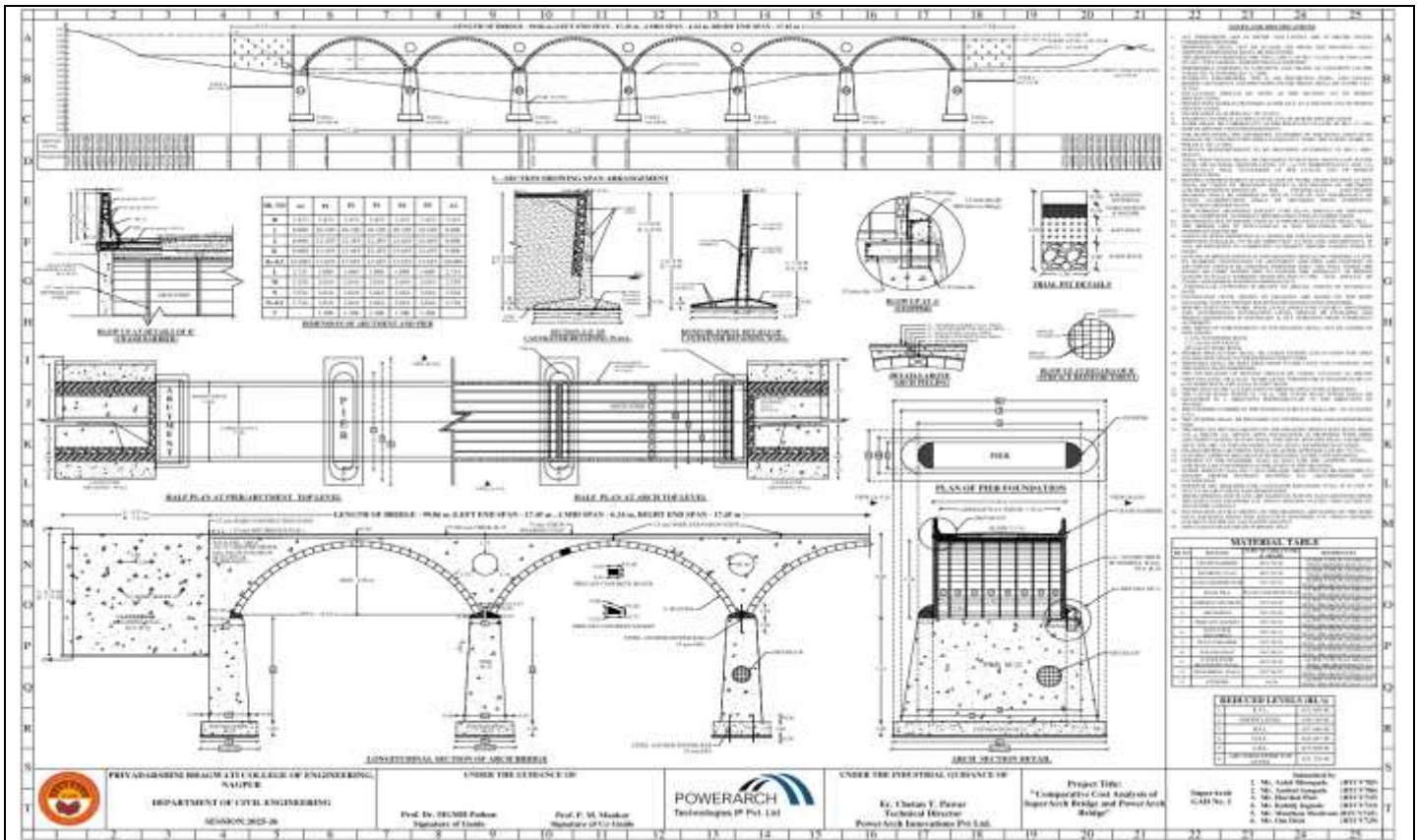


Fig. 7: Trial -1 (SuperArch GAD)

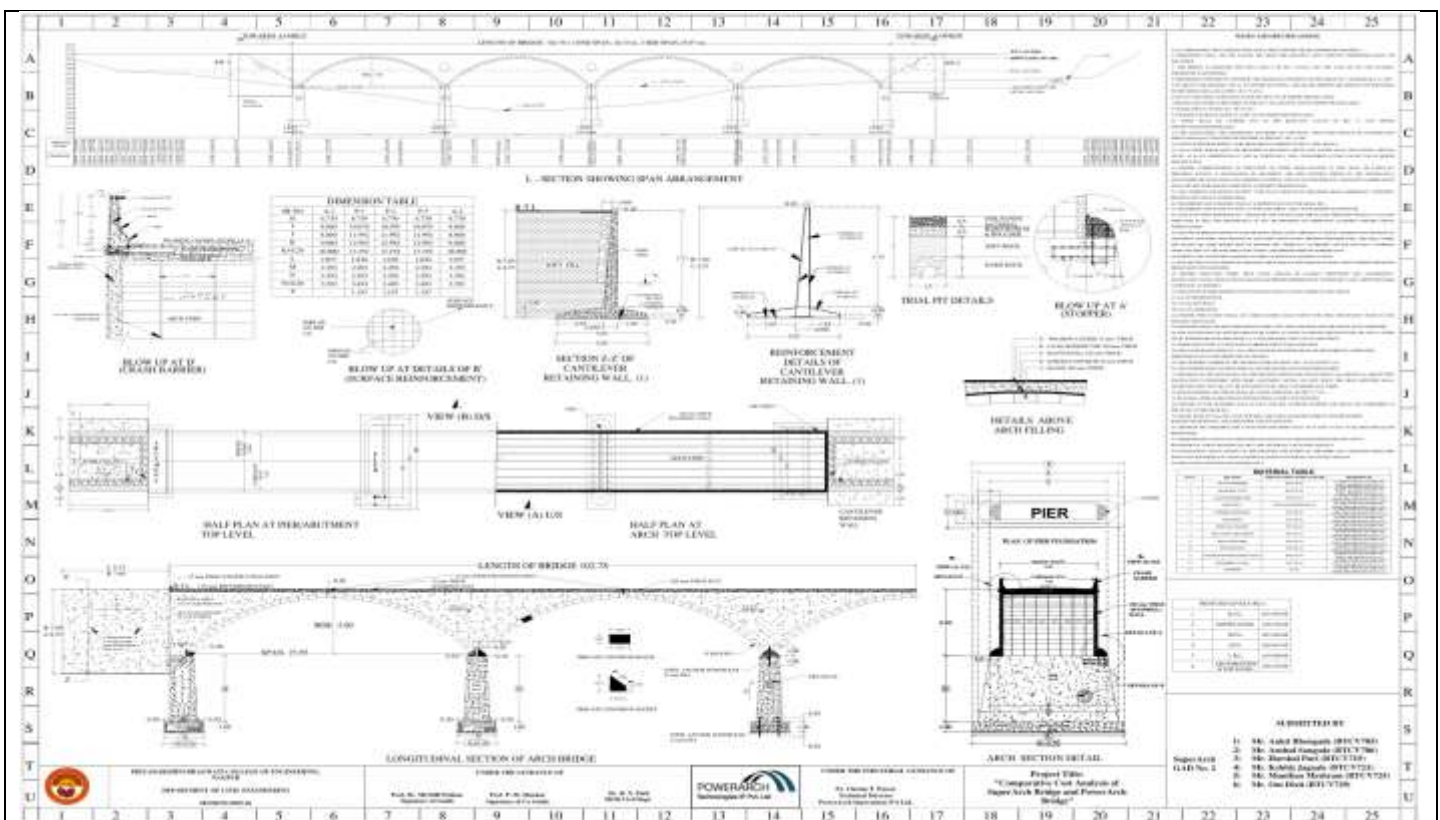


Fig. 8: Trial -2 (SuperArch GAD)

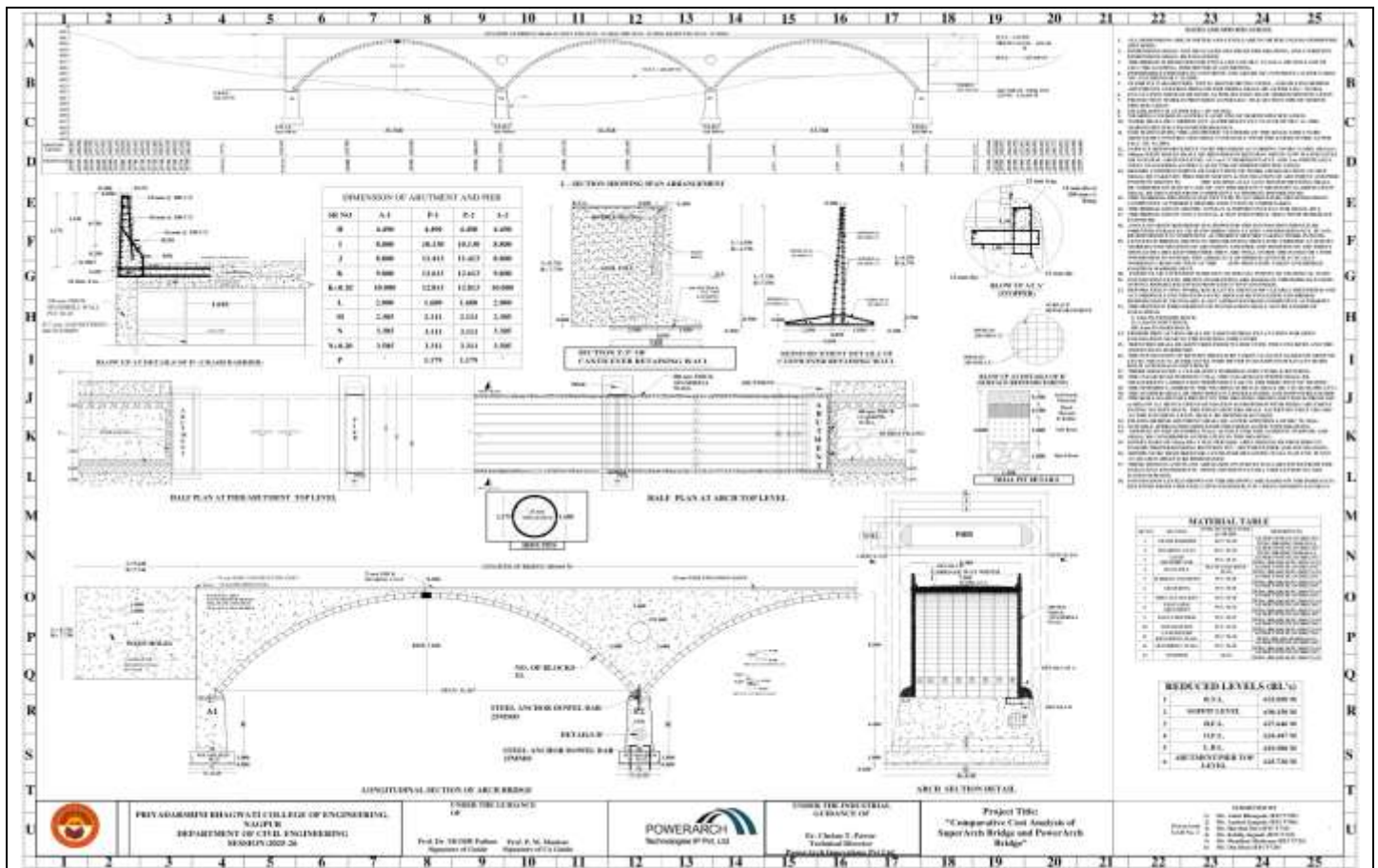


Fig. 9 : Trial -3 (SuperArch GAD)

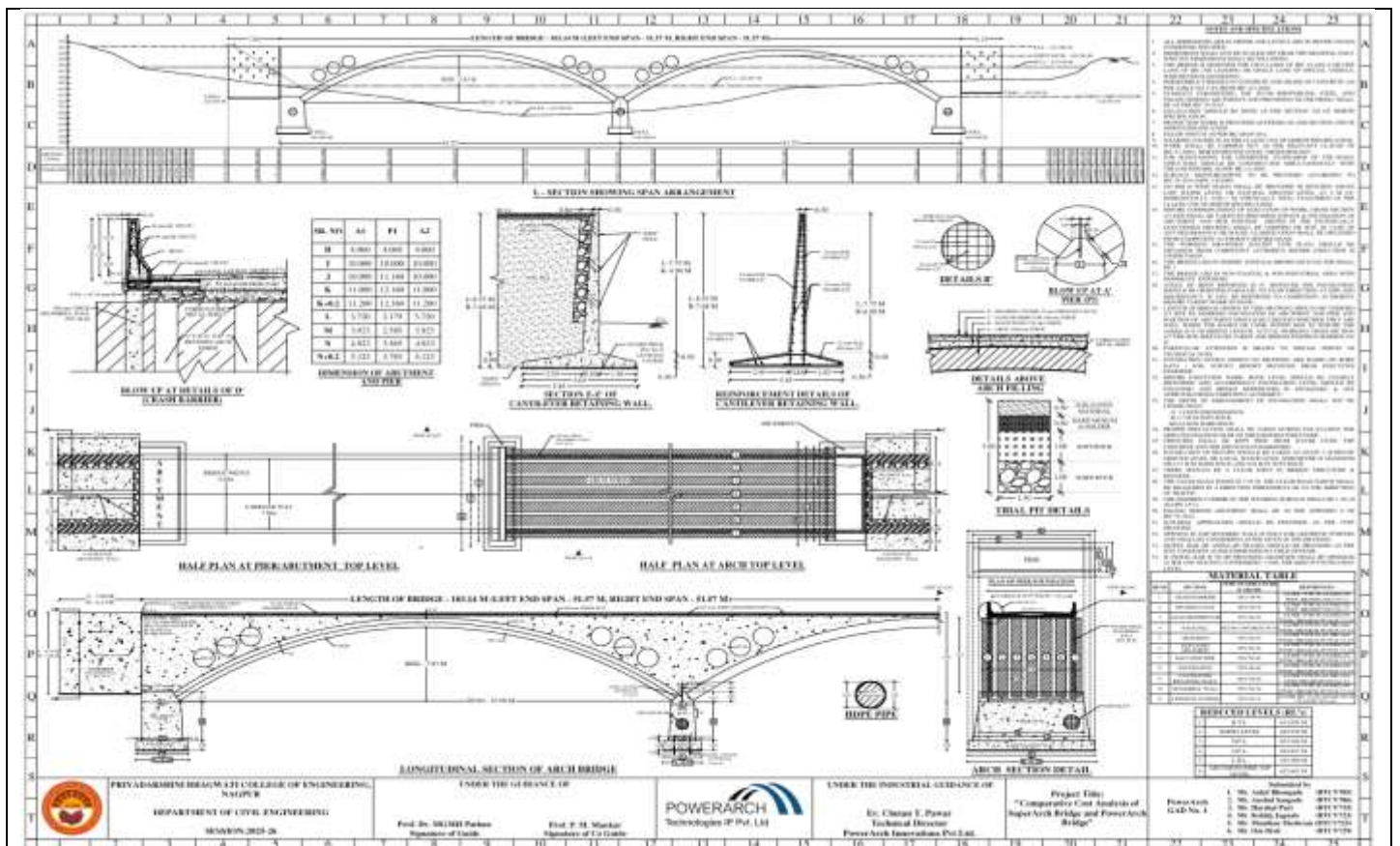
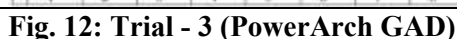
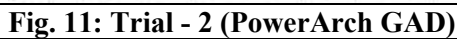


Fig. 10: Trial - 1 (PowerArch GAD)



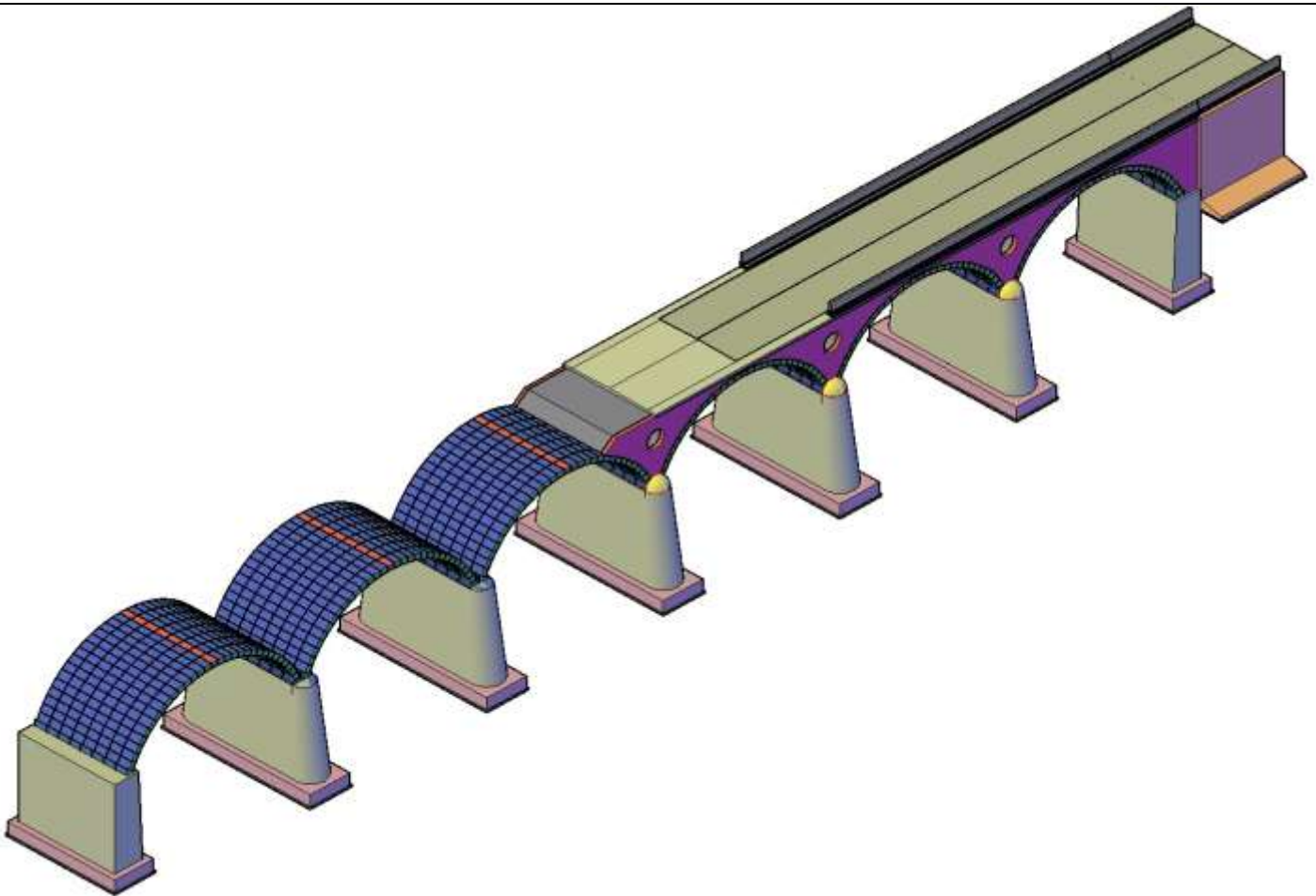


Fig. 10: Trial - 1 (SuperArch Bridge 3D Model)

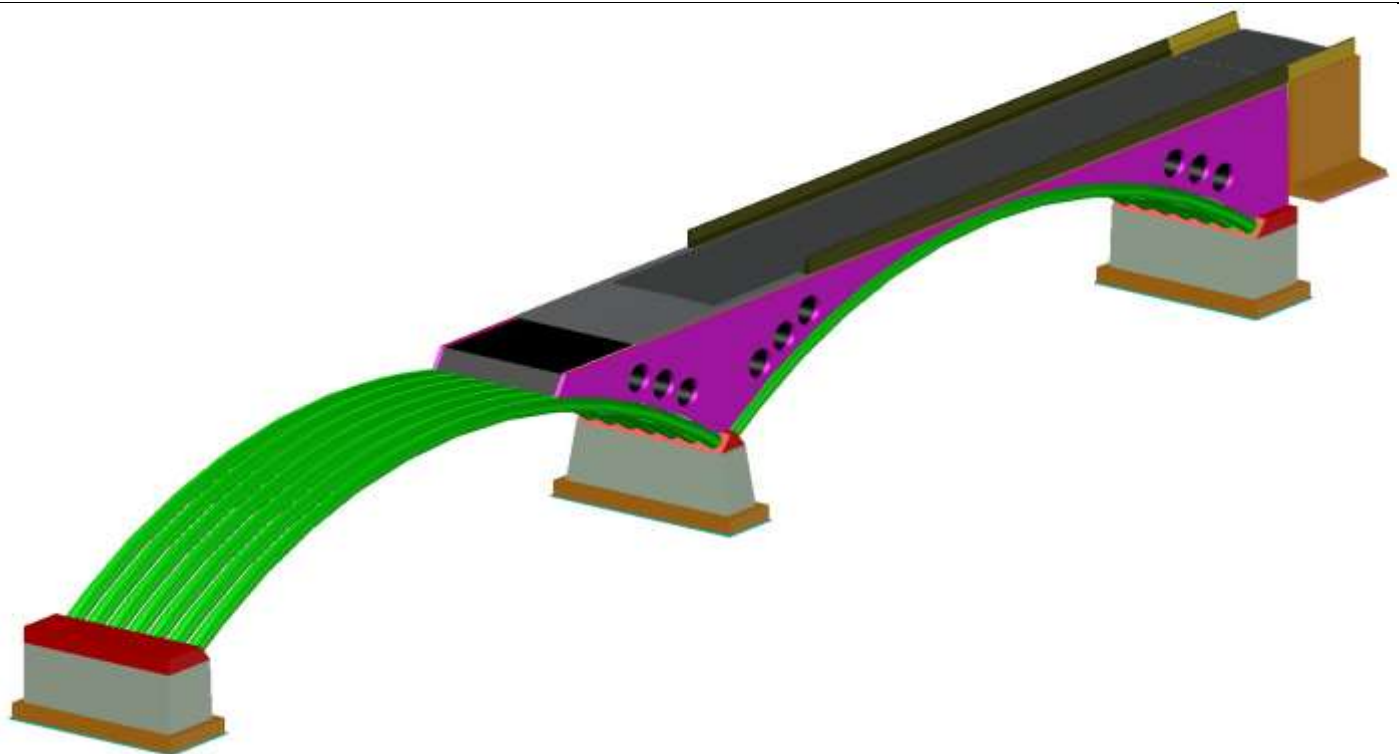


Fig. 14: Trial - 1 (PowerArch Bridge 3D Model)