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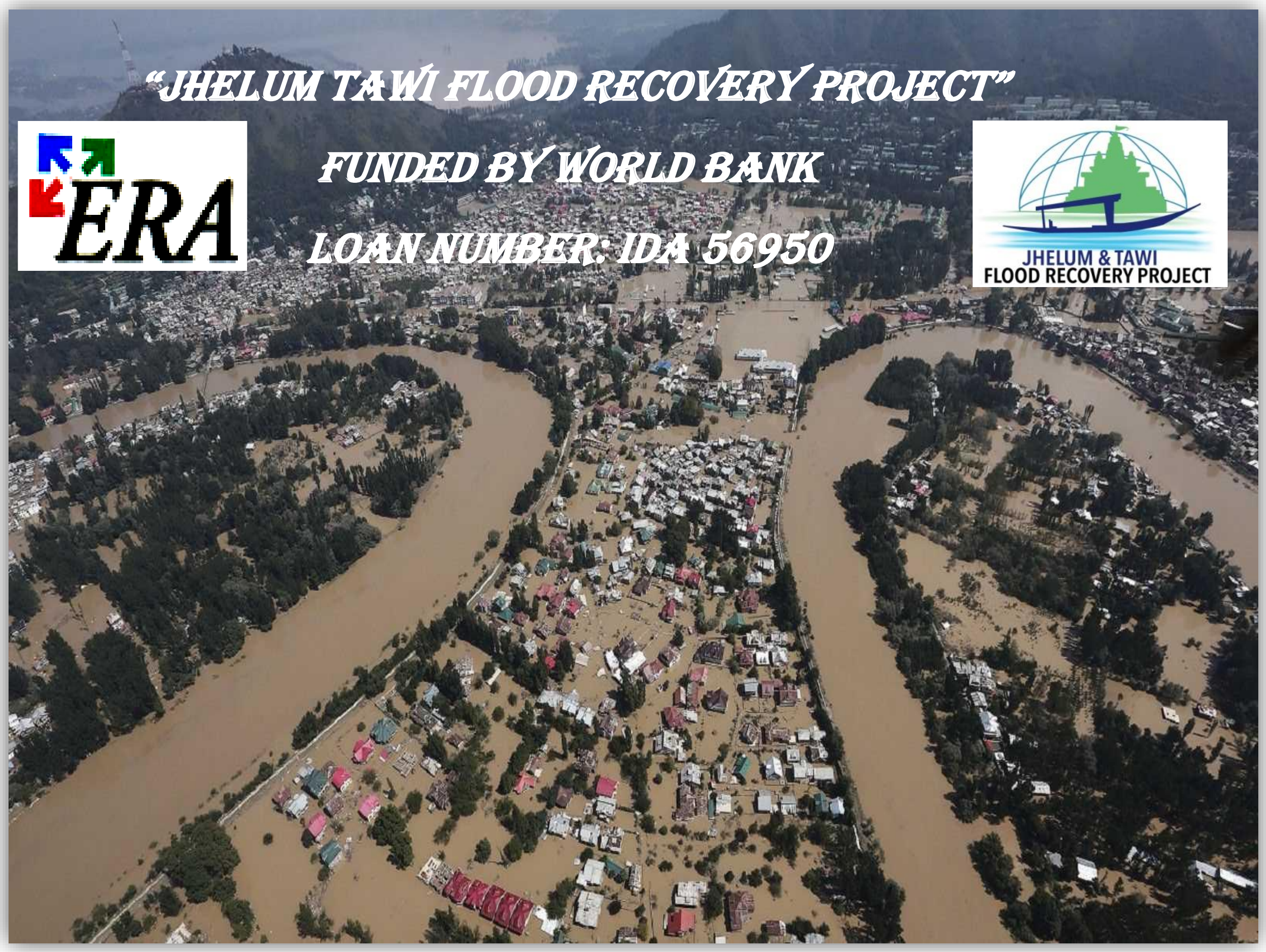
SUB-PROJECT COMPLETION REPORT



"JHELUM TAWI FLOOD RECOVERY PROJECT"

FUNDED BY WORLD BANK

LOAN NUMBER: IDA 56950

COMPONENT – II

RECONSTRUCTION OF ROADS & BRIDGES

VOLUME – I (BRIDGES)

Prepared By: Lea Associates South Asia Pvt. Ltd.

Technical Assistance & Quality Audit Consultants

VOLUME-I

Design and Construction of Bridges in Kashmir Division.

WAYIL BRIDGE

TRENZ BRIDGE

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SUB-PROJECT COMPLETION REPORT OF BRIDGES UNDER JTFRP KASHMIR DIVISION

PMU JTFRP KASHMIR

1. Introduction

1.1 Project Background

In September 2014, Jammu & Kashmir experienced torrential monsoon rains in the region causing major flooding & landslides. The continuous spell of rains from September 2-6, 2014 caused Jhelum and Chenab Rivers as well as many other streams/tributaries to flow above the danger mark. The Jhelum River also breached its banks flooding many low-lying areas in Kashmir, including the capital. In many districts, the rainfall exceeded the normal by over 600%. The Indian Meteorological Department (IMD) records precipitation above 244.4 mm as extremely heavy rainfall and J&K received 558mm of rain in the June – September period as against the normal 477.4 mm. For example, the district of Qazigund recorded over 550 mm of rainfall in 6 days as against a historic normal of 6.2 mm over the same period.

Due to unprecedented heavy rainfall the catchment areas particularly the low-lying areas were flooded for more than two weeks. Some areas in urban Srinagar stayed flooded for 28 days. Water levels were as high as 27 feet in many parts of Srinagar. The areas from the main tributaries of river Jhelum vis-à-vis Brengi nallah, Vishow nallah, Lider nallah and Sandran nallah started overflowing due to the heavy rainfall causing water levels in Jhelum to raise. Subsequently, the discharge of the river Suran was 200 thousand cusecs as against an average of 50 thousand cusecs. With the excessive discharge of water, the river Suran affected the basin areas and also took a different course at various locations causing damages to the surrounding villages in the catchment area. Water levels also increased in the rivers of Chenab and Tawi, both of which were flowing above normal levels. Due to the rivers overflowing nearly 20 districts of the State were impacted.

A Joint team led by the Department of Economic Affairs (DEA), GoI, with representation from the World Bank visited J&K on October 21, 2014. Subsequently, GoI has sent a request to the World Bank on January 5, 2015 to field a joint Rapid Damage and needs Assessment (RDNA) Mission within the State. In response, a mission of the World Bank visited the State during February 1-6, 2015 in order to produce a rapid multi-sectored assessment report of the damages and needs. The RDNA estimates the total damages and loss caused by floods at about INR 211.975 Million, most of it to housing, livelihoods; roads and bridges which combined represented more than 70% of the damages in terms of value. Public service infrastructure and equipment of hospitals and education centers were also severely damaged and were still not fully operational.

The primary focus of the project "Jhelum & Tawi Flood Recovery Project" is on restoring critical infrastructure using international best practice of resilient infrastructure. Given the region's vulnerability to both flood and earthquakes, the infrastructure will be designed with upgraded resilient feature, and will include contingency planning for future disaster events. Therefore, a study followed by detailed reports on flood management aims at both restoring essential services disrupted by the floods and improving the design standards and practices resilience.

The Government of India has received a loan from the World Bank towards the cost of Jhelum &Tawi Flood Recovery Project (JTFRP) for Government of Jammu and Kashmir. The Disaster Management, Relief & Rehabilitation Department, Government of J&K has been appointed as the implementing agency. One Project Management Unit (PMU) has been set up under this implementing agency which is responsible for overall project management, coordination and reporting.

Based on the Rapid Damage Needs Assessment (RDNA): Results, restoration works underway and discussion with the GOJ&K, the project will focus on resorting critical infrastructure using international best practice on resilient infrastructure. Given the state's vulnerability to both floods and earthquakes, the infrastructure will be designed with upgraded resilient features and will include contingency planning for further disaster events. Therefore, the project aims at both restoring essential services disrupted by the floods and improving the design standard and practices in the state to increase resilience.

1.2 Project Development Objective: The Project Development Objective (PDO) is to support the recovery and increase disaster resilience in targeted areas of the state and increase the capacity of the state entities to respond promptly and effectively to an eligible crisis or emergency.

1.3 Project Components:

The project is comprised of the following seven components:

1. Reconstruction and strengthening of critical infrastructure (US$50 million)
2. **Reconstruction of roads and bridges (US$80 million)**
3. Restoration of urban flood management infrastructure (US$40 million)
4. Restoration and strengthening of livelihoods (US$15 million)
5. Strengthening disaster risk management capacity (US$25 million)
6. Contingent Emergency Response (US$45 million)
7. Implementation Support (US$20 million).

Total Amount is US$ 250 Million.

Component 2 – Reconstruction of Roads and Bridges, US$80million

The objective of this component was to restore and improve the connectivity disrupted due to the disaster through the reconstruction of damaged roads and bridges. The infrastructure has been designed to withstand earthquake and flood forces as per the latest official design guidelines. The affected areas will benefit by the restored access to markets, inter district connectivity thereby increasing the economic growth in these areas and timely access to health and education services. Restoration of roads will also serve as supply/rescue lines in the event of a disaster.

The component financed the reconstruction of damaged roads, bridges and associated drainage and slope stabilization works, retaining walls, breast walls and other structures to increase resilience.

BRIDGES CONSTRUCTED UNDER THE WORLD BANK-FUNDED JTFRP

The bridge subprojects implemented under this component focus on restoring, rehabilitating, and upgrading critical/vital bridge structures across the Jammu & Kashmir. These interventions were targeted at enhancing and improving connectivity, structural integrity, and mitigating vulnerabilities caused by recurring floods and natural disasters. These interventions address key issues such as structural deterioration, inadequate load-bearing capacity, damaged approaches, missing safety features, and limited resilience against hydraulic forces. By adopting systematic design improvements and modern construction practices, the subprojects under JTFRP aimed to re-establish reliable, all-weather linkages between major road networks and remote communities in the flood-affected regions of J&K. The upgraded bridges are expected to enhance transport efficiency, support socio-economic development, and improve access to essential services including healthcare, education, and markets. Furthermore, these bridges play a vital role in strengthening disaster preparedness and response, providing critical routes for emergency evacuation, relief, and recovery operations during natural calamities.

The bridge sub-projects selected for upgrading were critical links in the regional and national transportation network, providing essential connectivity across rivers and streams that otherwise divide communities and economic zones. These bridges connect Srinagar and surrounding towns to key destinations such as the airport, markets, hospitals, schools, and residential areas, and they serve as lifelines for freight movement, emergency services, and daily commuting. Upgrading these bridges therefore support mobility, economic activity, and access to essential services across the J&K.

The bridge infrastructures were adversely affected by multiple factors, including the severe 2014 floods, repeated inundation, scouring around piers and abutments, inadequate flood relief capacity, sedimentation, and chronic drainage problems. Many crossings had exhibited structural distress from age, corrosion, water-borne debris impact, and weakening foundations caused by erosion and siltation. Poor maintenance practices over the years - delayed repairs, insufficient inspection regimes, and lack of timely rehabilitation had allowed deterioration to progress to the point where several bridges were functionally deficient or had posed load restrictions that constrain traffic and emergency response.

In several cases, the existing bridge components, including decks, bearings, and foundations, had displayed signs of distress and wear beyond their designed service life, proving insufficient to accommodate the increasing traffic volumes and heavier vehicle loads typical of the region's evolving transportation demands. Adverse weather conditions and persistent drainage issues further exacerbate degradation. Consequently, the sub-project prioritizes upgrading the affected bridges to enhance safety, durability, and resilience. This involved comprehensive structural repairs, replacement or strengthening of deficient elements, improved hydraulic capacity for flood resilience, and adoption of modern engineering standards to ensure long-term functionality. Since these bridges were upgraded in flood-prone areas, the design phase incorporated several key considerations, including raising the bridge profile where feasible, optimizing hydraulic performance, and using flood-resistant materials and protective coatings for submerged components. These measures were aimed at minimizing submergence risks and enhancing the overall structural integrity of the bridges during high-water events. The upgraded bridges restored critical connectivity and support socio-economic activities by ensuring uninterrupted and safe transit for both people and goods across the Kashmir Valley.

Many of the bridges were constructed decades ago and have received numerous ad hoc repairs over the years, resulting in inconsistent structural details and a mix of materials and connection types that complicate inspection, maintenance, and load performance assessments. In addition to comprehensive physical rehabilitations, specific resilience and durability measures were implemented across bridge subprojects: foundation and pier scour protection, installation of adequate deck and superstructure drainage (longitudinal and cross-deck drainage systems and scuppers), replacement or upgrading of expansion joints and bearings, and localized embankment raising at bridge approaches to reduce the risk of approach submergence and loss of access. Where required, interventions also included strengthening or replacement of substructure elements (e.g., concrete jacketed piers, micro-pile underpinning), application of corrosion protection systems and high-performance deck materials, and installation of access for maintenance and inspection to ensure consistent long-term performance and safety.

This project was dedicated to the comprehensive restoration and enhancement of critical bridge infrastructure within the region. The goal was to fortify these structures against future environmental challenges, improve traffic efficiency, significantly reduce accident rates, and guarantee seamless connectivity for daily commuters and emergency services alike. The upgraded bridges were engineered with a forward-thinking approach, aiming to provide sustainable, high-quality infrastructure. This ensures their longevity and continued support for the local economy. Ultimately, these efforts will enhance the overall quality of life for residents in the affected areas by providing robust and reliable transportation links.

List of the Completed Bridge Sub-Projects under Component-2 of JTFRP in Kashmir Region

S.No.	Project Type	Sub-projects	Span/Length (in meters)	Design Consultants	District
Design and Construction of:					
1.	EPC Mode	1x110 meter Span Semi Arch Steel Trussed Girder Bridge Over River Sindh at Wayil in District Ganderbal	1x110=**110**	S. Guha Niyogi and Associates	Ganderbal, J&K
2.	EPC Mode	1x25 meter span plate girder bridge on Raine Nallah at Kaliban in District Baramulla.	1X25= **25**	Matrix Engineers civil & structural Consultants	Baramulla J&K
3.	EPC Mode	1x45 meter span trussed Girder Bridge on Rambiara Nallah at Kumar Mohalla Wachi in District Shopian.	1x45= **45**	Matrix Engineers civil & structural Consultants	Shopian, J&K
4.	EPC Mode	3x30 m. span steel truss girder bridge on Bringi Nallah at Sadora- Asajipora Kamad Road in District Anantnag.	3x30= **90**	Matrix Engineers civil & structural Consultants	Anantnag, J&K
5.	EPC Mode	2 Lane bridge on Vaishav Nallah at Chamgund in District Kulgam	10x40= **400**	Matrix Engineers civil & structural Consultants	Kulgam, J&K
6.	IRC Mode	Construction of 3 x 50 m span double lane through type trussed girder bridge at Rohmoo Pulwama	3x50= **150**	GVG Consultants	Pulwama, J&K
7.	IRC Mode	Construction of 6 x 50 m span double lane through type trussed girder bridge at Trenz Sheikhpora Shopian over Rambiara nallah	6x50= **350**	GVG Consultants	Shopian, J&K

2. Executive Summary:

- **Objective:**

The objective of this project was to restore and upgrade vital bridge infrastructure across key locations in the Jammu & Kashmir, strengthening connectivity, improving safety, and increasing resilience to natural disasters (particularly flooding). The initiative addresses chronic vulnerabilities such as structural degradation, insufficient scour protection, and limited load capacity, while ensuring reliable, all-weather crossing points that remain operable during and after extreme events. The infrastructure was designed in accordance with the latest official design guidelines, with the objective of ensuring resilience against seismic and flood forces. A key objective of the project was to construct bridge decks and critical structural elements above the High Flood Level (HFL) as recorded during the 2014 floods, thereby ensuring adequate freeboard and reducing the risk of overtopping and structural damage during extreme flood events. The reconstructed bridge network aims to restore and strengthen connectivity to markets, healthcare facilities, and educational institutions in the affected areas, while also serving as a critical supply, evacuation, and emergency response corridor during future disaster events.

The project was designed with the objective of delivering a resilient and sustainable bridge network through the adoption of advanced engineering solutions, including reinforced concrete superstructures, enhanced pier and abutment protection, improved scour countermeasures, and the use of durable materials and construction practices to minimize flood induced damage and extend service life.

Safety and traffic efficiency objectives were addressed by widening approach spans where feasible, eliminating hazardous sightlines, upgrading parapets and guardrails, and improving access ramps to safely accommodate emergency and heavy vehicle movements.

Overall, the works aim to provide a high-quality, climate-resilient bridge network that supports economic activity, ensures reliable access to essential services, and strengthens disaster preparedness and response capacity, thereby enhancing the overall quality of life for communities across the affected areas.

- **Summary of Achievement:**

This project focused on restoring and upgrading critical bridge infrastructure in the Kashmir Valley, aiming to improve connectivity, safety, and resilience to natural disasters like flooding. *Initially, a total of 13 bridges were proposed for construction under JTFRP in Kashmir province. However, one bridge namely, the Gogjidaji Bridge at Tarzo, Sopore was subsequently dropped due to a dispute. Of the remaining bridges, seven (07) have been successfully restored and enhanced, while five (05) are currently under construction at various stages of development.* These interventions addressed significant issues such as structural deficiencies, inadequate load-bearing capacity, and vulnerability to scour and flood damage. The result is the establishment of all-weather connectivity, which has markedly improved access to markets, facilitated inter-district movement, and enhanced reach to essential healthcare and education services, thereby stimulating local economic growth.

Key improvements included strengthening bridge foundations, repairing and rebuilding superstructures, and implementing advanced drainage and flood mitigation measures to ensure continued functionality during adverse weather conditions. The introduction of innovative construction techniques and durable materials, such as high-strength concrete and improved scour protection, provided resilient solutions against flood damage and reduced long-term maintenance costs. Overall, the upgraded bridge infrastructure has significantly improved access to vital services and established a reliable network crucial for disaster response and recovery, delivering substantial long-term social and economic benefits to the region.

2.1 Introduction & Background

This project focused on upgrading and restoring critical bridge infrastructure across the Kashmir Valley, an area severely affected by floods and other environmental challenges in recent years. The project is managed by the R&B Kashmir, acting as the Project Implementation Unit (PIU), with support from various agencies and stakeholders. The region's bridge network has faced significant challenges, including structural degradation, inadequate load-bearing capacity, and severe damage from scour and erosion, particularly exacerbated by narrow waterways, poor hydraulic design, and flood-induced impacts. This project was designed to address these issues by upgrading key bridges, particularly those that connect Srinagar city to essential areas such as the airport, markets, and residential zones, and those vital for inter-district connectivity. In the aftermath of the 2014 floods, these bridges became even more vulnerable due to submergence, increased hydraulic pressure, and the deterioration of their structural components.

The subproject was initiated under the Jhelum and Tewi Flood Recovery Project (JTFRP) to provide a sustainable and resilient transportation network for the region. By focusing on bridge restoration and enhancement, it aims to ensure reliable crossings that can withstand future environmental challenges, improve connectivity, and support the overall socio-economic development of the Kashmir Valley.

The bridges selected for upgrading include some of the most vital crossings in the region, characterized by high traffic volumes and strategic importance. These include critical bridges along key arteries, with examples such as those connecting essential urban and rural centers, or those providing crucial links over significant water bodies. These includes Chambgund Bridges, Wayil bridge, Rohmoo Bridge, Trenz Bridge, Sadoora Bridge etc. All selected bridges underwent significant structural enhancements and, where applicable, improvements to approach roads, representing a major step forward in resilient infrastructure development.

In addition to structural rehabilitation, the project encompasses comprehensive hydraulic and safety improvements. These include strengthening foundations, enhancing scour protection, improving waterway openings to accommodate higher flood discharge, and the construction of protective works such as RCC retaining walls, wing walls, and robust parapets. The upgraded bridges also feature improved drainage systems on their decks and approaches, including the installation of longitudinal drains and culverts, to ensure effective management of storm water and prevent erosion or damage to the bridge structure and its embankments.

The subproject's overarching goal was to provide durable, safe, and flood-resistant bridge infrastructure that supports economic development, enhances public safety, and improves access to critical services. This ensures long-term sustainability and resilience to future environmental challenges, securing vital connectivity for the region.

2.2 Sub-Project Detail

The R&B Kashmir, under the World Bank-financed Jhelum Tawi Flood Recovery Project (JTFRP), has successfully finalized the restoration and reconstruction of 12 bridges across multiple districts affected by the 2014 Kashmir floods. These bridge projects were strategically selected based on the extent of flood damage, structural vulnerability, and their critical role in ensuring connectivity and emergency access. The subprojects were organized into comprehensive inclusive agreements designed to enhance flood and seismic resilience by adhering to updated standards from MoRTH and IRC, tailored to local topography and hydrology. Covering key regions such as Srinagar, Baramulla, Anantnag, and Ganderbal, the projects emphasize climate-adaptive engineering, incorporating features such as improved foundations, scour protection, hydrological design considerations, and the use of flood resistant materials. These infrastructural upgrades aim to restore important socio-economic lifelines, improve traffic flow, and support disaster response capabilities, thereby contributing to the region’s sustainable recovery and long-term resilience.

The comprehensive project report, along with the detailed design and construction ready drawings, was prepared by concerned contracting agencies, while LEA Associates South Asia Pvt. Ltd. (TAQAC) provided technical assistance and quality audit services during the construction phase. All bridge construction contracts were awarded to qualified and experienced contractors through a transparent and competitive bidding process. The scope of work involved the Design, construction, and rehabilitation of bridges to ensure structural stability, enhanced connectivity, and all-weather accessibility. The works also included approach roads, gabion/crate wall protections, drainage improvement measures, and safety provisions such as crash barriers and pedestrian pathways.

The table below presents the key details of each completed bridge subproject, including bridge type, total length, contractor name, financials (sanctioned, revised, and final completion costs), and timelines covering commencement and actual completion dates.

Contract Details of the completed Bridge Sub-projects under JTFRP

S. No.	Name of Bridge Sub-project	Type of Bridge	Name of PIU	Name of Contractor	Total span of Bridge in meter	Allotted cost (in Crores)	Revised cost (in Crores)	Completion cost (in Crores)	Date of Start (as per Allotment)	Date of Completion (Actual)
1.	Design and Construction of two-lane Bridge over Nallah Sindh at Wayil Ganderbal	Semi Arch Truss Girder Bridge	R&B Ganderbal	M/s M.M. Shawl Engineers and contractors Pvt. Ltd.	110	23.79	26.84	27.84	27-June-19	26-May-23
2.	Construction of 6 x 50 m span double lane through type trussed girder bridge at Trenz Sheikhpora Shopian over Rambiara nallah	Truss Girder Bridge	R&B Shopian	JKPCC/ M/s M.M. Shawl Engineers and contractors Pvt. Ltd.	30	34.50	39.41	Completion Certificate has not yet been submitted by the PIU (R&B).	01-Nov-17	25-Oct-25
3.	Design and Construction of Bridge (3x30 m) at Asajipora Kamad Sadoora road (km 4th), Anantnag	Truss Girder Bridge	R&B Anantnag	M/s Khanday Infrastructure pvt ltd	90	6.31	6.39	6.45	09-Nov-20	30-June-23
4.	Construction of 3 x 50 m span double lane trussed girder bridge at Rohmoo Pulwama	Truss Girder Bridge	R&B Pulwama	JKPCC/ M/s Tarmac	150	21.25	25.98	Completion Certificate has not yet been submitted by the PIU (R&B).	01-Nov-17	31-March-25

S. No.	Name of Bridge Sub-project	Type of Bridge	Name of PIU	Name of Contractor	Total span of Bridge in meter	Allotted cost (in Crores)	Revised cost (in Crores)	Completion cost (in Crores)	Date of Start (as per Allotment)	Date of Completion (Actual)
5.	Design and Construction of Bridge at Kulgam Chambgund road km 1st RD700 (10x40 Mt)	Truss Girder Bridge	R&B Kulgam	M/s Tarmac	400	32.40		32.40	28-Nov-20	30-June-23
6.	Design and Construction of Bridge (1x45 mtr) over nallah Rambiara at Kumar Mohalla Wachi, Shopian	Truss Girder Bridge	R & B Shopian	M/s Khanday Infrastructure pvt ltd	45	3.11	3.11	3.11	16-Apr-19	30-June-23
7.	Design and Construction of Bridge at Kalaiban, Baramulla	Plate Girder Bridge	R&B Baramulla	M/s Altaf Constructions	25	2.64	2.64	2.64	01-Sep-20	01-July-22

DETAILS OF THE STAKEHOLDERS		
1	Project Implementation Unit (PIU).	R & B Kashmir
2	Project Management Unit (PMU)	JHELUM TAWI FLOOD RECOVERY PROJECT (JTFRP)
3	Design Consultant	S. Guha Niyogi and Associates, Matrix Engineers civil & structural Consultants, GVG Consultants.
3	Quality Audit Consultants	LEA ASSOCIATES SOUTH ASIA PVT LTD. (TAQAC)
4	Funding Agency	The World Bank

3. Bridge Details:

3.1 Wayil Bridge, Ganderbal

Design and Construction of 1x110 meter Span Semi Arch Segmental Through Type Steel Trussed Girder Bridge Over River Sindh at Wayil in District Ganderbal including construction of Approach Roads and Nallah Training work

3.1.1 INTRODUCTION & PRE-EXISTING FEATURES:

The Wayil Bridge subproject, undertaken under the World Bank-funded Jhelum Tawi Flood Recovery Project (JTFRP), involves the design and construction of a landmark 2-lane, single-span steel semi arch-truss girder bridge with a span of 110 meters and a deck width of 10.5 meters, supported by robust approach roads extending approximately 330 meters.

During the 2014 floods, cloudbursts in the upper reaches of Kangan caused a sharp rise in the River Sindh, resulting in extensive damage to property, agricultural land, and infrastructure in Ganderbal district. The abutments of the under-construction Wayil Bridge were washed away, while the existing Bailey Bridge sustained partial damage. Seven makeshift bridges in Kangan Tehsil, including those at Hung Park, Yachama, Ramwari, Hilpati, Plapora, Satrina, and Tangcheter, were destroyed, cutting off connectivity to the Srinagar–Leh highway. The Bramsar Nallah bridge at Chatergul also collapsed, inundating nearby habitations. Several localities, including Gagangeer, Kasana Pati, Mamar, Cherwan, Cheki Akhal, Preng, Watalbagh, Devpora, Korag, Pati-Saloora, Narainbagh, Pati-Shalbug, and Gund Roshan, were submerged. The floodwaters rose to within one foot of the Mini Secretariat Ganderbal compound, highlighting the severity of the disaster

Prior to construction of the new Wayil bridge, the crossing over River Sindh was served by an existing bridge that functioned as the primary crossing for local traffic. The old structure was of limited capacity (single-lane carriageway) and exhibited multiple signs of distress: localized deck deterioration and potholing, exposed and corroded reinforcement, damaged parapets and bearings, and evidence of scour and erosion at the foundations. The carriageway width and structural capacity were inadequate for current vehicular loads, forcing traffic restrictions and detours for heavy vehicles. Approach roads and transition works were substandard, creating safety hazards and frequent congestion during peak periods. Seasonal high flows in the Sindh River further exposed the bridge's vulnerability to flood damage. Given these conditions, the replacement/rehabilitation was required to

(a) provide a wider, load-rated crossing to accommodate modern traffic (including emergency and service vehicles),

(b) improve structural resilience against scour and floods,

(c) Enhancement of riding quality and connectivity, ensuring reliable all-weather passage and reducing travel time for users.

(c) enhance road safety with proper approaches, parapets and drainage, and

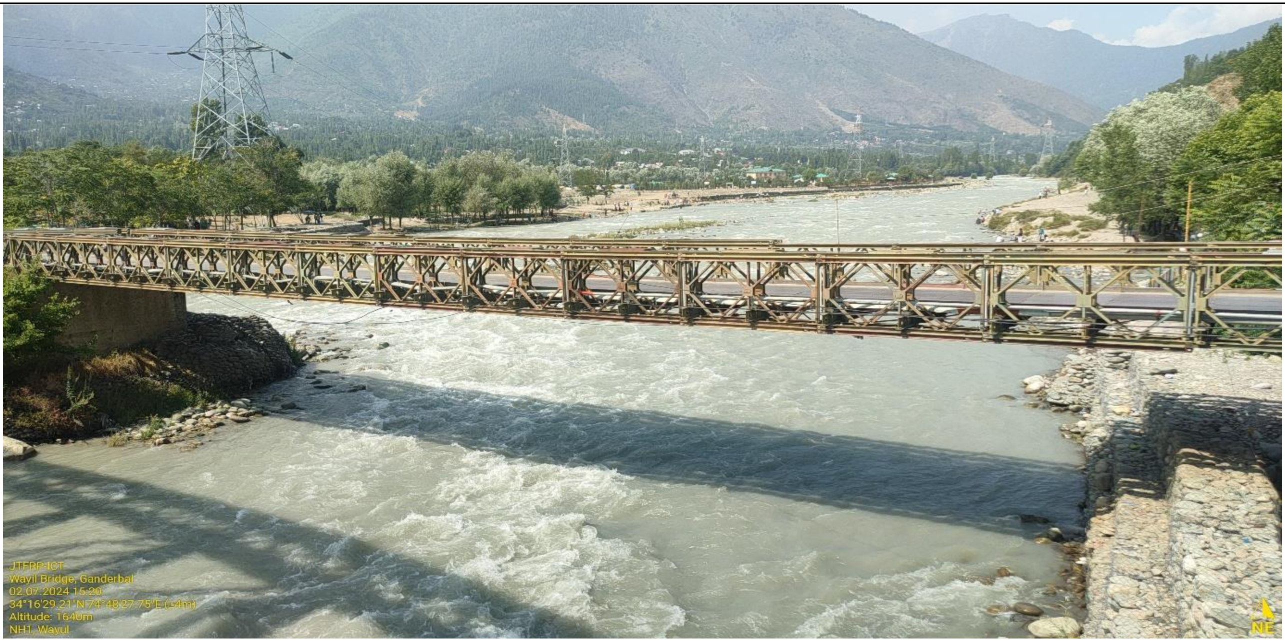
(d) support socio-economic development by ensuring uninterrupted, reliable connectivity for people, goods and services.

The subproject focused on restoring and upgrading a critical section of the Srinagar-Leh National Highway within Ganderbal district, Kashmir Valley. The intervention aims to address longstanding connectivity gaps, improve road safety standards, and remedy infrastructure vulnerabilities exacerbated by recurring floods and natural disasters in the region.

This bridge subproject was in Engineering, Procurement and Construction (EPC) mode contract for "Design and Construction of 1x110 meter Span 2 Lane Steel Semi–Arch Bridge over River Sindh at Wayil in District Ganderbal, Jammu & Kashmir" and environmental enhancement measures etc as per the best engineering practices, in compliance to the World Bank policies and in synchronization with project environmental management strategies. The bridge has a span configuration of 1x110 meters with semi arch steel trussed girder superstructure with 230 mm thick RCC deck slab and footpath. The bridge has a clear carriageway of 7.50 meters and a provision of a 1.5 m wide Footpath on both sides of the bridge. The constructed bridge is 7.6 Km towards N-W from District headquarters Ganderbal and 20.56 Km from State capital Srinagar.

This subject bridge is a landmark single-span steel semi arch structure, representing the first execution of its kind within the Kashmir valley. The bridge extends uninterrupted from one riverbank to the other, with the entire deck supported exclusively by the arch and no intermediate piers or supports placed within the waterway. This configuration ensures that Sindh River flowing beneath the structure remains wholly unobstructed, thereby enhancing flood resilience, structural longevity, and compliance with environmental protection standards. The bridge approaches are comprehensively reinforced with stone pitching and robust embankment stabilization measures, providing effective protection against riverbank erosion and scour. Continuous safety parapets and guardrails are installed along the entire length of the deck, ensuring the safety of both vehicular and pedestrian traffic.

This engineering solution exemplifies modern design priorities maintaining hydraulic continuity, minimizing the environmental footprint, and delivering superior structural performance within a sensitive mountainous terrain.



Existing temporary Bailey bridge at Wayil, Ganderbal, used to maintain connectivity prior to the construction of the new resilient bridge.

Image illustrating the damaged abutment and deteriorated structural condition of the existing Bailey bridge.

PRE-EXISTING CONDITIONS:

- **Bridge Condition:** The existing Steel Bailey Bridge was in fair to poor condition, showing deterioration in several structural components such as corroded panels, damaged decking, and loose or missing bolts. The bearings and approach slabs were also in distress, affecting the overall stability of the bridge. The bridge condition deteriorated further after the 2014 floods, which caused significant scouring and alignment issues, leading to prolonged disruption of connectivity to nearby villages.

- **Bridge Deck Width:** The average carriageway width of the existing Steel Bailey Bridge was 3.0 meters, which was below the standard single-lane bridge width of 3.75 meters. The absence of adequate footpaths or safety kerbs further restricted usable width for vehicular movement, resulting in limited maneuverability and reduced safety for both vehicles and pedestrians.
- **Protection Works:** This included composite crate work and PCC wall at the Approaches of the bailey bridge. These structures were in a deteriorated state with visible cracks, loss of mortar, and signs of erosion. Substantial repair and strengthening were required to prevent soil displacement, scouring, and further damage to the bridge approaches.

3.1.2 BRIDGE UPGRADES & IMPROVEMENT

The Wayil Bridge Sub-project at Ganderbal was implemented as a critical component of the regional infrastructure development program to enhance safety, functionality, and resilience of river crossings and connecting routes. The project addressed key challenges identified during preliminary assessments, including replacement and rehabilitation of the existing steel Bailey bridge structure, strengthening of foundations and abutments, improvement and widening of bridge approaches, and augmentation of drainage and protective works. These interventions ensure reliable all-weather connectivity, enhanced structural stability, and improved transportation efficiency across the Sindh River, thereby supporting socio-economic development in the region.

Design Phase Intervention (Wayil Bridge)

During the design phase of the Wayil Bridge, the original proposal envisioned a 110-meter single-span steel truss bridge. However, during detailed site assessment and planning for girder launching, a critical hindrance was identified on the Manigam side due to the presence of an existing 132 KV transmission line directly across the proposed alignment. This obstruction rendered it technically infeasible to launch the full length truss girders as per the original design.

To address this constraint and ensure structural balance as well as construction feasibility, the bridge design was modified by introducing two 10-meter dead spans (composite plate girders) one at each end of the main span. This modification allowed the construction team to retain the visual and structural symmetry of the bridge, while ensuring safe launching operations could be carried out within the available working corridor and required safety clearances from the transmission line.

This design intervention reflects a pragmatic engineering solution that effectively balanced field constraints with structural performance requirements, minimizing disruption to existing utilities while maintaining the overall integrity and functionality of the proposed bridge structure.

The new features added to the Wayil Bridge, compared to the previous Steel Bailey Bridge, include several significant improvements:

Increased Structural Span and Capacity: The new Wayil Bridge spans over 110 meters and was designed to weigh over 700 metric tons of mild steel for the superstructure, providing a longer and stronger crossing compared to the older structure.

Wider Deck and Better Accessibility: The latest design includes a carriageway width of 7.5 meters along with 1.5-meter-wide footpaths on both sides, offering improved safety for pedestrians and vehicles alike. This is an upgrade from the narrower carriageway of the old structure.

Improvement of Protection Works - Reinforced earth walls (R.E Pannels/RCC walls):

A total length of 426 meters of retaining walls (comprising of R.E panels, 185 m and RCC, 241m) were constructed for bridge approaches.

Additionally Link Roads of the length 323.5 meters (towards Gutlibagh side, 266m and towards Manigam link, 57.5) were constructed to benefit the adjacent villages.

Enhanced Load-Bearing and Safety Features: The new bridge was constructed using a robust combination of truss and semi arch bridge elements with girders, ensuring it can bear higher traffic loads and adverse weather conditions, addressing limitations of the old Bailey design.

Mitigation of Seismic and Flood Impacts: Geotechnical design enhancements that improve the geomatrix's resilience against lateral forces due to seismic activity or flood-induced soil liquefaction, thereby ensuring foundation stability under adverse conditions.

Modern Construction Materials and Techniques: Use of earthquake-resistant and corrosion-protected materials enhances durability and longevity, which was a challenge for the older steel Bailey bridge subjected to the region's harsh climate and floods.

Pavement Upgradation:

The Approach Road surface was upgraded with 50mm thick Bituminous Macadam (BM) and 25mm Open Graded Premix Carpet (OGP). This upgrade provides high-quality smoothness and durability, making it resilient to traffic and harsh weather.

Improvement of cross drainage structures:

Two NP4 Hume pipe culverts of 1000 mm diameter was installed across the approach road towards Ganderbal, having lengths of 20 m. These culverts were provided to improve water runoff management and facilitate the smooth passage of irrigation water across the road, thereby serving the adjoining paddy fields.

Nallah Protection Works: A total of 200 meters of gabion walls were constructed at various sections along the upstream and downstream sides of the Wayil Bridge. This intervention was carried out to effectively mitigate soil erosion and prevent slope instability along the banks of the Sindg river. The gabion walls serve as a durable and environmentally sustainable erosion control measure, fully aligned with the project's environmental safeguard requirements.

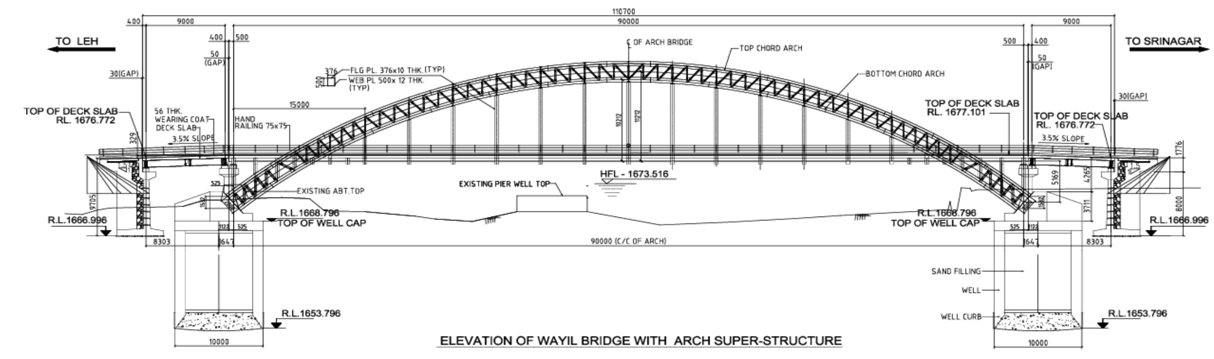
Road marking & Road signs:

Thermoplastic road markings, enhanced with reflective glass beads, were meticulously applied on both sides of the bridge deck and its approach roads. This application strictly adhered to the guidelines outlined in IRC: 35-2015, ensuring consistent quality and performance. The primary objective was to significantly improve visibility for motorists, particularly during low-light conditions and at night, thereby enhancing overall road safety.

The inclusion of reflective glass beads within the thermoplastic material plays a crucial role in retro reflectivity. These beads, embedded in the marking, reflect vehicle headlamp light back to the driver's eyes, making the road markings appear brighter and more discernible. This feature is especially vital for delineating the carriageway boundaries across the entire length of the bridge and its approaches, where clear guidance is paramount. Additionally, reflective road studs (cat’s eyes) were installed along the carriageway to further enhance night-time visibility and lane guidance, thereby improving overall traffic safety across the bridge and its approaches.

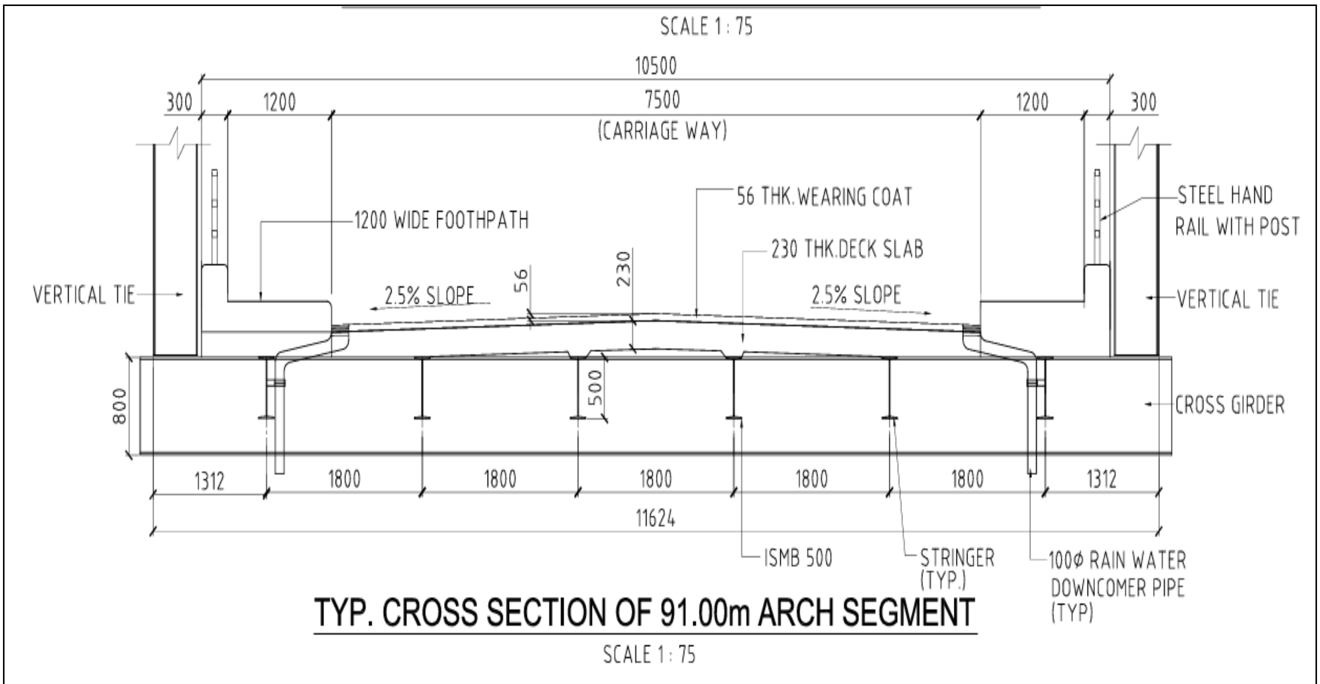
The comprehensive application of these high-visibility markings throughout the bridge and its approach road ensures a continuous and reliable visual cue for drivers. By following IRC: 35-2015 standards, the project guarantees that the reflective properties and durability of the road markings meet national specifications, contributing to safer travel conditions across the entire project stretch.

10 road signs were strategically placed, including mandatory, cautionary, and informative signs, complying with IRC: 67-2012.



1x110.0m SPAN SEMI ARCH SEGMENTAL THROUGH TYPE STEEL TRUSSED GIRDER
GIRDER BRIDGE AT WAYIL, OVER NALLAH SINDH, GARDERBAL, SRINAGAR (J&k)
GARDERBAL, SRINAGAR (J&K)

Longitudinal Section of Wayil Bridge, Ganderbal



Transverse section of the Wayil Bridge, Ganderbal

Salient Features of completed Wayil Bridge at Ganderbal

S.No.	Item	Description
1.	Span Arrangement	2x10 and 1x90 meter
2.	No. of Spans	3
3.	Type of Bridge	High-Level Motorable Major Bridge
4.	Substructure	RCC Wall Abutments with open foundations RCC Wall type Pier cum Abutment with well foundations
5.	Superstructure	Steel Trussed Girder with RCC Deck Slab compositely Constructed
6.	Carriageway	Double lane CW of 7.50 mts width
7.	Footpaths	1.50-meter Footpath on either side of CW.
8.	Bearing	POT/PTFE Bearings as per Design Load capacity
9.	Stream	Sindh stream

10.	Approaches	- A total of 426 -meter approaches on both sides of the bridge was constructed with RE panel/RCC retaining wall
11.	Nallah Training Works	Wire Gabion nallah protection works in several tiers both on U/S for 150 mts & D/S for 50 mts of the bridge.
12.	Expansion Joint	Strip Seal Type
13.	Elevated Deck Design	*The High Flood Level (HFL) at Wayil Bridge, Ganderbal as recorded during the 2014 floods, was 1673.516 m.* The bottom level of the bridge deck has been set at 1675.49 m, well above the maximum flood level recorded in 2014. The finished top level of the bridge deck has been set at 1677.151 m, providing adequate additional freeboard above the flood level recorded during the 2014 event. This elevated deck configuration will effectively prevent overtopping and restricts floodwater ingress into the bridge superstructure.

Impacts

The Wayil Bridge serves as a key lifeline for economic activities, offering quick, reliable access to essential services, markets, health, and education facilities for a population of approximately 184556. It has strategic importance for disaster response and recovery, providing improved readiness and accessibility for relief and rescue operations during flooding or other emergencies. The new bridge will spur regional tourism, facilitate pilgrimage routes (e.g., Amarnath Yatra), and support trade between Kashmir and Ladakh, thereby supporting robust economic growth and development.

The project has undergone stringent quality checks covering environmental, civil, and mechanical domains as per World Bank and Indian standards for resilient infrastructure.

This subproject exemplifies contemporary bridge engineering and sustainable infrastructure upgrade, delivering significant benefits in terms of connectivity, safety, disaster resilience, and socio-economic upliftment for the Kashmir Valley.

A cornerstone achievement was the pioneering construction of an end-to-end, pier-less bridge at Wayil Ganderbal, representing a significant advancement in regional engineering. This innovative design, the first of its kind in the Kashmir Valley, dramatically improves hydraulic performance by eliminating obstructions to water flow, thereby enhancing the river's natural dynamics. The absence of intermediate piers also substantially reduces long-term maintenance demands and offers a sleeker, more aesthetically pleasing structure, showcasing a new benchmark for structural efficiency and design in the region.

A view of completed Wayil Bridge at Ganderbal

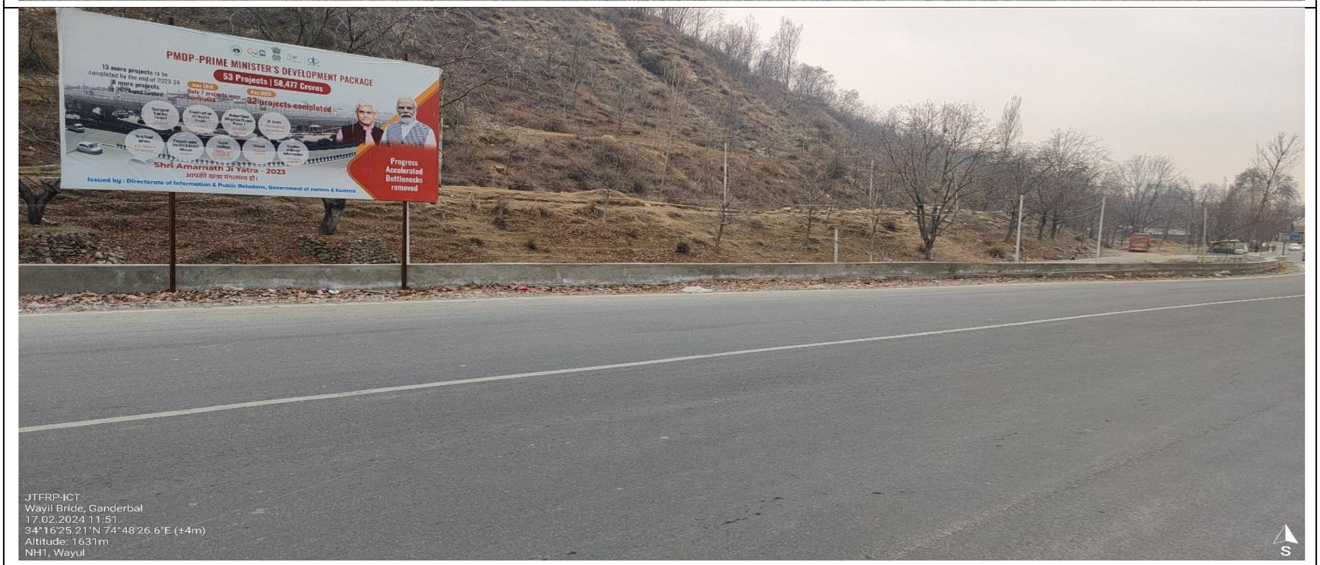
Views of the Wayil Bridge superstructure showing the composite Semi arch steel truss system, longitudinal girders, deck slab, top braccing, Bituminous top, and footpaths.

A view of Approach Road of Wayil Bridge towards Manigam.

A view of Approach Road of Wayil Bridge towards Ganderbal.

A view of 1.50m wide footpath on both sides of the Wayil bridge

LEA Associates South Asia Pvt. Ltd.
Office of the JTFRP-TAQA Consultant
2nd floor, ERA Commercial Complex, Rambagh
Srinagar - 190009



Views of link roads constructed around the Wayil bridge site to facilitate the local transportation.

Views of Gabion walls constructed along the upstream and downstream extents of the Wayil Bridge, illustrating the application of gabion structures for effective riverbank stabilization and slope protection.

Along the gabion wall, the Zamindari Canal has been constructed to divert a portion of the Sindh River flows for irrigation purposes, thereby providing direct irrigation benefits to the local farming communities.

Two NP4 Hume pipe culverts of 1000 mm diameter was installed across the approach road towards Ganderbal, having lengths of 20 m. These culverts were provided to improve water runoff management and facilitate the smooth passage of irrigation water across the road, thereby serving the adjoining paddy fields.

3.2 Sadoora Bridge, Anantnag

Design and Construction of 3x30 meter Steel Trussed Girder Bridge on Bringi Nallah at Sadoora-Asajipora Kamad Road in District Anantnag, including construction of Approach Roads and Nallah Training work.

3.2.1 INTRODUCTION & PRE-EXISTING FEATURES:

The Sadoora Bridge Subproject, implemented under the World Bank-funded Jhelum Tawi Flood Recovery Project (JTFRP), involves the design and construction of a double-lane trussed girder bridge having 3 spans of 30 meters each (3x30 m) across the Bringi Nallah at Sadoora-Kamad, Anantnag District, Jammu & Kashmir. The scope of work further encompasses the construction of approach roads on both abutments and the execution of comprehensive nallah training and protection works to ensure the structural integrity, hydraulic efficiency, and long-term sustainability of the bridge and its adjoining infrastructure.

This bridge at Sadoora is a major/vital connecting link between Sadoora, Kamand, Vessu, Lallan, Ganoora, Ugjan, and Asajipora besides connecting district headquarter Anantnag. The bridge was constructed on Sadoora-Asajipora Kamad Road connecting vast area to NH 44. The bridge will also serve indirectly to thousands of other souls of the other adjoining areas as it links these areas with National Highway and district head-quarter.

The Sadoora village was connected with main district with a 6x20 ft span submersible vented causeway, which was washed away due to devastating flood of September 2014. During episodes of torrential rains, the villages get disconnected with other habitations and people of the area especially students, patients face a lot of difficulties in absence of connectivity over said Nallah during the rainy season. To address this long-pending public demand and ensure reliable access, a new 3 × 30meter Truss Girder Bridge has been constructed over the Bringi Nallah.

PRE-EXISTING CONDITIONS:

The road connecting several villages in South Kashmir remained cut off multiple times after the temporary Sadoora Bridge over Nallah Bringi suffered extensive damage. Despite substantial expenditure on its restoration and the construction of a temporary diversion following the washing away of the main bridge during the 2014 floods, thousands of inhabitants residing on either side of the Nallah were compelled to take a longer alternate route due to the non-reconstruction of the main bridge.

The bridge served as a vital link providing connectivity between dozens of villages and the main town of Anantnag. The original concrete vented causeway-type bridge was completely washed away during the 2014 floods. Subsequently, the local residents, using their own resources, constructed a temporary diversion to restore limited connectivity.

The route passing over the Sadoora Bridge and connecting Fatehpora and Larkipora is considered a secondary highway, as it is frequently used by commuters from Qazigund, Vessu, and several adjacent villages who prefer it as a bypass to avoid congestion along the Khanabal route.

In 2014, the heavy discharge in Bringi Nallah washed away several temporary makeshift bridges and diversions, severely disrupting connectivity in the area. The worst affected were local residents, including government employees, students, and businessmen, who faced immense hardships commuting between villages. According to locals, some were even compelled to wade through the river to save time.

The route holds significant importance for residents of Sadoora and Kamad villages situated on either side of the Bringi Nallah as the Sadoora Railway Station lies along this alignment. People from dozens of nearby villages rely on this route to access Anantnag town.

In April 2017, the authorities constructed a small iron Bailey-type bridge across the river, with approach roads on either side built using boulders. However, intense rainfall during June 2018 caused widespread damage across South Kashmir, washing away the approaches to this temporary bridge and rendering it nonfunctional once again. Repeated temporary repairs proved unsustainable, resulting in recurring public inconvenience and expenditure.

To provide a permanent and reliable solution, the construction of a 3 × 30 meter Steel Truss Girder Bridge with deck over Bringi Nallah was constructed, including the associated approach roads and Nallah training works. This project aims to ensure all-weather connectivity for the residents and address the long-pending public demand for a durable crossing structure in the area.

Views of the temporary Bailey bridge and vented causeway installed on the RHS of the newly constructed permanent bridge at Sadoora, Anantnag. This provisional structure, erected post-2014 floods to restore critical connectivity, sustained multiple instances of damage from recurring high flows and required repeated repairs.

Condition of Approach Road from Sadoora side prior to construction.

Condition of Approach Road from the Kamad side prior to construction.

Views of remnants from the previously damaged Sadoora Bridge at Anantnag, illustrating the extensive structural deterioration and debris left by recurrent flooding events prior to the JTFRP reconstruction efforts

3.2.2 BRIDGE UPGRADE AND IMPROVEMENT

The Sadoora bridge over Bringi Nallah in District Anantnag, Jammu & Kashmir, was constructed with a total length of 90 meters with a 3×30 meter span configuration. The superstructure comprises open web steel girders (Warren truss pattern with verticals) supporting a reinforced concrete composite deck slab. This arrangement provides a clear carriageway of 7.50 meters with 1.50 meter-wide footpaths on both sides, including provisions for utility accommodation, particularly fresh water supply pipes.

Superstructure Details

All three spans maintain identical 30-meter configuration with Truss girders featuring a 6-meter truss height (measured from center of top chord to center of bottom chord). The design ensures optimal load distribution and resistance to flood-induced dynamic forces, compliant with IRC:6-2017 and IRC:22-2015 standards.

Substructure and Foundations

- End spans: Rest on RCC wall-type abutments at one end and RCC wall-type piers at the other.
- Central span: Supported on RCC wall-type piers with circular ends at both extremities.
- All substructures (abutments and piers) are founded on open foundations, designed for scour protection and stability per IRC: SP:114-2018.

Load transfer from superstructure to substructure is achieved through Pot/PTFE bearings with specified load capacities, accommodating thermal movements, rotation, and longitudinal/transverse displacements as per IRC:83 (Part 3)-2018.

Seismic Factor in Design Bridge

The bridge site at Sadoora on Bringi Nallah in Anantnag District is located in Seismic Zone V and prone to high-intensity earthquakes. While designing of bridge components, suitable seismic load factor was taken into consideration.

Snow Load on Proposed Bridge Site

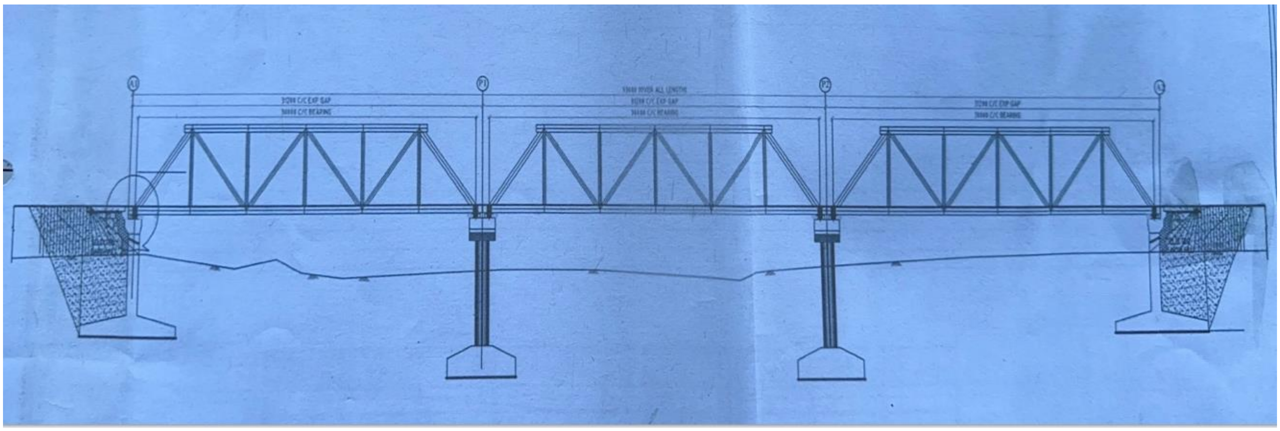
The 3x30 meter bridge at Sadoora in Anantnag District receives heavy snowfall which normally occurs during extreme winter. The design team of the contractor has considered the design parameters based on the snow load and included in the design aspects.

Nallah Training and Protection Works

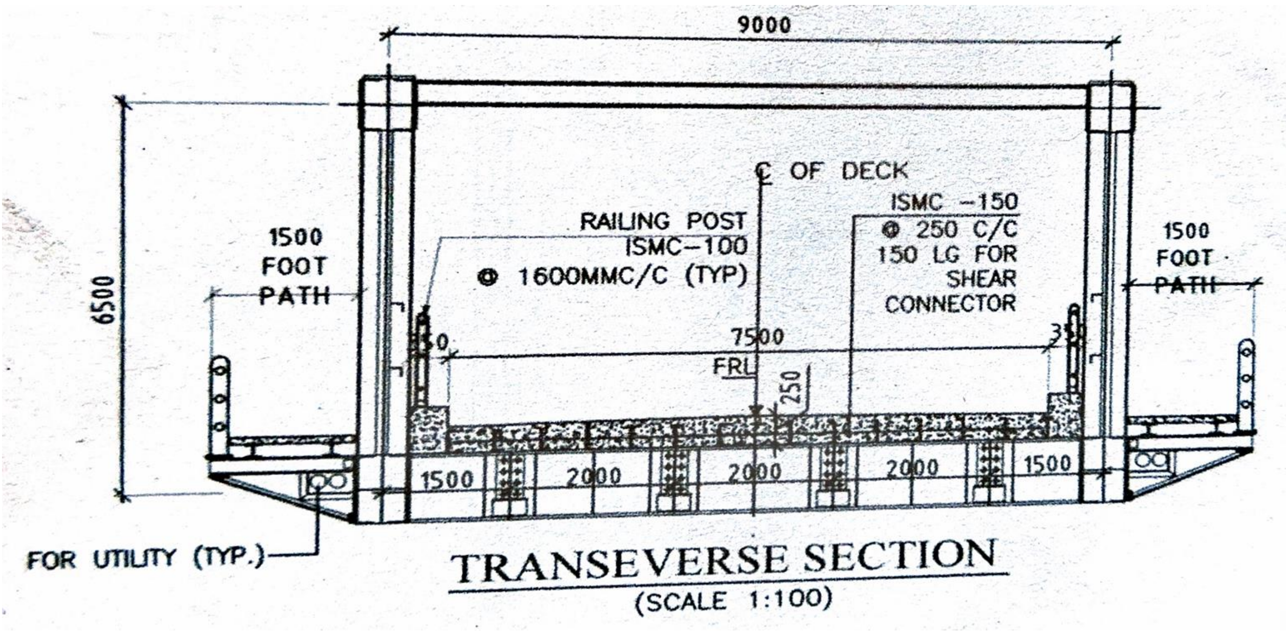
Nallah training works for Bringi Nallah are critical to protect the bridge, its foundations, and approach roads from the stream's dynamic and erosive forces. A total of 150 meters of crate wall was constructed along the upstream and downstream reaches of the bridge to ensure adequate protection and channel stability.

Pavement upgrades:

The Approach Road surface was upgraded with 50mm thick Bituminous Macadam (BM) and 25mm Open Graded Premix Carpet (OGP). This upgrade provides high-quality smoothness and durability, making it resilient to traffic and harsh weather.



Longitudinal Section of Sadoora Bridge



Transverse Section of Sadoora Bridge.

Salient Features of the Sadoora Bridge, Anantnag

S.No.	Item	Description
1.	Span Arrangement	3x30 meter
2.	No. of Spans	3
3.	Type of Bridge	High-Level Motorable Major Bridge
4.	Substructure	RCC Wall Abutments with open foundations RCC Wall type Piers with open foundations
5.	Superstructure	Steel Trussed Girder with RCC Deck Slab compositely constructed
6.	Carriageway	Double lane CW of 7.50 mts width
7.	Footpaths	1.50-meter Footpath on either side of CW.
8.	Bearing	POT/PTFE Bearings as per Design Load capacity
9.	Stream	Bringi nallah/ stream
10.	Approaches	- A total of 120-meter approaches on both sides of bridge was constructed with RCC approach wall.
11.	Nallah Training Works	Wire Crate nallah protection works in several tiers both on U/S for 150 mts & D/S for 50 mts of the bridge.
12	Expansion Joints	Strip Seal Type
13.	Elevated Deck Design	*The High Flood Level (HFL) at Sadoora Bridge, Anantnag as recorded during the 2014 floods, was 1627.81 m.* The bottom level of the bridge deck has been set at 1629.05 m, well above the maximum flood level recorded in 2014. The finished top level of the bridge deck has been set at 16307.921 m, providing adequate additional freeboard above the flood level recorded during the 2014 event. This elevated deck configuration will effectively prevent overtopping and restricts floodwater ingress into the bridge superstructure.

Impacts:

The bridge design incorporates flood and seismic-resilient features in accordance with the latest BIS guidelines and IRC specifications. The elevated truss girder design over the Bringi Nallah allows water to flow freely during high discharge periods, with provisions for vents and openings to accommodate flood flows. This resilient design ensures the infrastructure can withstand future flood events, serving as a critical supply and rescue line during disaster situations.

The bridge directly addresses connectivity challenges faced by Sadoora village and neighboring settlements including Kamad, Vessu, Lallan, Ganoora, Ugjan, and Asajipora. The new bridge will eliminate this seasonal isolation and provides year-round connectivity to the district headquarters at Anantnag (6.7 km away) and the capital city of Srinagar (66.3 km away), as well as connections to National Highway 44. The Sadoora Bridge will confer direct benefits upon approximately 108,816 individuals.

The region's economy is predominantly characterized by walnut cultivation and fruit growing. The newly constructed bridge will serve as a transformative enabler of market access for these agricultural communities. By facilitating efficient transport of horticulture and agricultural products to distant markets, the bridge will substantially enhance long-term economic growth and livelihood sustainability in the area. Producers will benefit from reduced transportation costs, shortened transit times, and improved product quality upon delivery to markets, thereby creating new opportunities for value addition and premium market positioning for locally-grown produce.

Lateral views of the completed Sadoora Bridge in Anantnag, showcasing the fully erected double-lane truss girder superstructure.

A view of the Sadoora Bridge superstructure showing the composite steel truss girder system, longitudinal girders, Bituminous top, and safety wheel guard with steel railing.

A view of the approach roads of the Sadoora Bridge, Anantnag.

Views of parapets constructed atop the approach retaining walls at Sadoora Bridge, Anantnag, providing essential lateral safety barriers, vehicle containment, and pedestrian protection.

Traffic rotary constructed on the approach road to Sadoora Bridge, Anantnag, facilitating efficient vehicular circulation, safe merging from multiple access points, and optimized traffic flow for enhanced connectivity and reduced congestion.

A view of 1.50m wide footpath on both sides of the Sadoora bridge at Anantnag.

Views of Crate walls constructed along the upstream and downstream extents of the Sadoora Bridge, illustrating the application of crate structures for effective riverbank stabilization and slope protection.

3.3 Rohmoo Bridge, Pulwama

Construction of 3x50 m span double Lane through type trussed girder bridge at Rohmoo Pulwama, J&K.

3.3.1 INTRODUCTION & PRE-EXISTING FEATURES:

The existing bridge at Rohmoo over the Roomshi Nallah was completely destroyed during the devastating September 2014 floods in Pulwama District. This catastrophic failure was the primary justification for identifying the site as a priority replacement sub-project under the Jhelum and Tawi Flood Recovery Project (JTFRP), funded by the World Bank.

The bridge directly connects 12 villages and hamlets in Pulwama district, with a population of approximately 35,000 - 40,000 residents. These include Rahmoo, Mitrigam, Pakherpora, Zagigam, Putrigam, Tujan, Mirgund, Thokerpora, Tilsar, Char-e-Sharief, Yusmarg, and Kamrazipora. These villages experienced the most severe isolation after the 2014 floods destroyed the original bridge, and now benefit from.

The Rohmoo Bridge exemplifies multi-level regional development, simultaneously addressing rural connectivity gaps, supporting agricultural livelihoods, enabling disaster resilience, and promoting tourism and cultural heritage preservation across South Kashmir's four major districts.

Pre-Existing condition:

As the existing bridge at Rohmoo over the Roomshi Nallah was completely destroyed during the devastating September 2014 floods. Another damaged Bailey bridge along with vented causeway, located approximately 120 m upstream of the destroyed bridge, was subsequently utilized to restore temporary connectivity. This bridge comprised a modular steel structure designed for rapid emergency deployment. However, while Bailey bridges serve an essential short-term and emergency function, the pre-existing site conditions at Rohmoo highlighted inherent structural, hydraulic, and durability limitations, rendering the Bailey bridge configuration unsuitable as a sustainable long-term solution.

The bailey bridge configuration at Rohmoo was specifically vulnerable to the hydrological and seismic hazards of the Pulwama region. The Roomshi Nallah experiences extreme flood conditions, with a discharge capacity of 5,000 cubic meters per second during peak flows, a highest flood level (HFL) of 95.551 m, and a calculated scour depth of 3.95 m. The site is located in Seismic Zone V, the highest earthquake risk classification in India, with a history of major seismic events.

The existing Bailey bridge and vented causeway structure was of limited capacity, comprising a single-lane carriageway, and exhibited multiple signs of structural distress.

These included localized deck deterioration and potholing, exposed and corroded reinforcement, damaged parapets and bearings, as well as clear evidence of scour and erosion at the foundations. The inadequate carriageway width and insufficient load-carrying capacity failed to meet current vehicular demand, resulting in traffic restrictions and mandatory detours for heavy vehicles. Furthermore, the approach roads and transition works were substandard, giving rise to safety hazards and recurrent congestion, particularly during peak traffic periods. Seasonal high flows in the Rohmoo stream further exacerbated the bridge's vulnerability, significantly increasing the risk of flood-related damage. Fallen trees, boulders, and flood debris accumulate at bridge structures, creating additional hydraulic resistance and increasing water velocity.

In view of these deficiencies, replacement/rehabilitation of the bridge was imperative to achieve the following objectives:

(a) Provide a wider, load-rated crossing capable of safely accommodating modern traffic volumes, including emergency and service vehicles;

(b) Improve structural resilience against scour, erosion, and flood events.

(c) Enhance riding quality and overall connectivity, ensuring reliable all-weather access and reduced travel time for users;

(d) Strengthen road safety through properly designed approaches, parapets, and drainage systems; and

(e) Support socio-economic development by ensuring uninterrupted and dependable connectivity for the movement of people, goods, and essential services.

In response to these sustainability challenges, JTFRP and the J&K Economic Reconstruction Agency identified the replacement of the bailey bridge with a purpose-designed, permanent steel trussed girder bridge as the optimal solution.

A view of the pre-existing Bailey bridge at the Rohmoo Bridge site, pulwama

3.3.2 BRIDGE UPGRADE AND IMPROVEMENT

The Rohmoo Bridge project at Pulwama was implemented as a critical component of the regional infrastructure development program to enhance safety, functionality, and resilience of stream crossings and connecting routes. The project addressed key challenges identified during preliminary assessments, including replacement and rehabilitation of the existing steel Bailey bridge structure, strengthening of foundations and abutments, improvement and widening of bridge approaches, and augmentation of drainage and protective works. These interventions ensure reliable all-weather connectivity, enhanced structural stability, and improved transportation efficiency across the Rohmoo Stream, thereby supporting socio-economic development in the region. Key technical specifications include:

Length and Type: The bridge has been constructed as a 150-meter-long (or 3x50 meter span) double-lane trussed girder bridge. The fabrication of steel trussed girders is a crucial component of its construction.

Construction Materials: The structural steel used is Grade E-250, conforming to IS 2062 standards, ensuring strength and durability. Connections are made with 8.8 Grade HSFG nut bolts and all fabricated sections receive a coat of approved primer and enamel paint for protection against corrosion.

Safety Features: The bridge incorporates 50mm nominal bore GI pipes of medium grade as rails, complete with clamps and proper painting, adhering to technical specifications.

Wider Deck and Better Accessibility: The latest design includes a carriageway width of 7.5 meters along with 1.5-meter-wide footpaths on both sides, offering improved safety for pedestrians and vehicles alike. This is an upgrade from the narrower carriageway of the old structure.

Enhanced Load-Bearing and Safety Features: The new bridge is constructed using a robust combination of truss girder elements, ensuring it can bear higher traffic loads and adverse weather conditions, addressing limitations of the old Bailey bridge.

Mitigation of Seismic and Flood Impacts: Geotechnical design enhancements that improve the geomatrix's resilience against lateral forces due to seismic activity or flood-induced soil liquefaction, thereby ensuring foundation stability under adverse conditions.

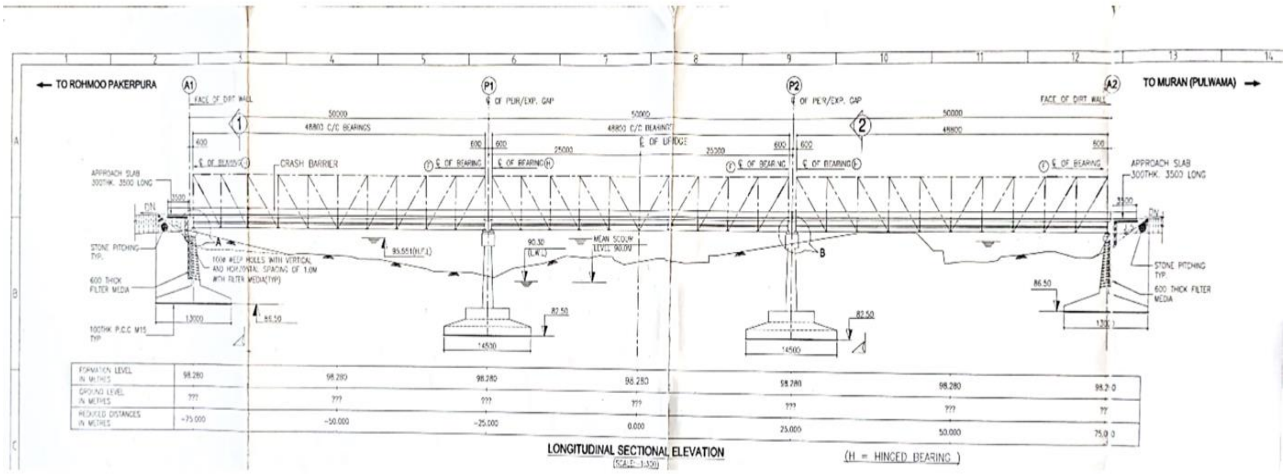
Modern Construction Materials and Techniques: Use of earthquake-resistant and corrosion-protected materials enhances durability and longevity, which was a challenge for the older steel Bailey bridge subjected to the region's harsh climate and floods.

Pavement upgrades:

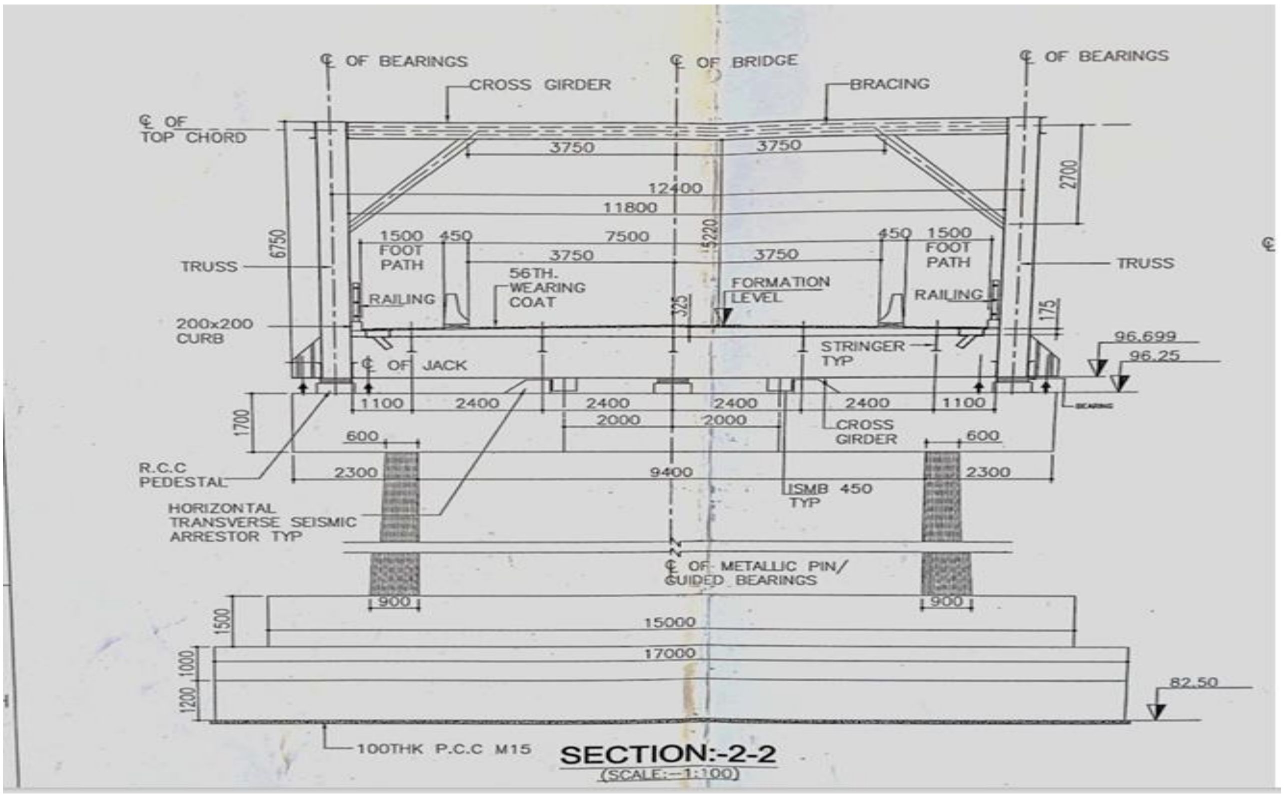
The Approach Road surface was upgraded with 50mm thick Bituminous Macadam (BM) and 25mm Semi Dense Bituminous Concrete (SDBC). This upgrade provides high-quality smoothness and durability, making it resilient to traffic and harsh weather.

Improvement of cross drainage structures:

Multi barrel pipe culvert of 1200 mm diameter was installed at across the approach road towards Pulwama side, having lengths of 15 m. The culvert was provided to improve water runoff management and facilitate the smooth passage of irrigation water across the road, thereby serving the adjoining paddy fields.



Longitudinal Section of Rohmoo Bridge, Pulwama



Transverse Section of Rohmoo Bridge, Pulwama

Salient Features of Rohmoo Bridge, Pulwama

S.No.	Item	Description
1.	Span Arrangement	3x50 meter with an overall length of 150 meters.
2.	No. of Spans	3
3.	Type of Bridge	High-Level Motorable Major Bridge
4.	Substructure	RCC Wall Abutments with open foundations RCC Wall type Piers with open foundations
5.	Superstructure	Steel Trussed Girder with RCC Deck Slab compositely constructed
6.	Carriageway	Double lane CW of 7.50 mts width
7.	Footpaths	1.50-meter Footpath on either side of CW.

8.	Bearing	POT/PTFE Bearings as per Design Load capacity
9.	Stream	Rohmoo nallah/ stream (tributary of the River Jhelum)
10.	Approaches	A total of 350-meter approaches on both sides of the bridge with RCC approach wall.
11.	Nallah Training Works	Crate work nallah protection works in several tiers both on U/S for 50 mts & D/S for 100 mts of the bridge
12.	Expansion Joints	Strip Seal Type
13.	Elevated Deck Design	*The High Flood Level (HFL) at Romoo Bridge, Pulwama as recorded during the 2014 floods, was 95.551 m.* The bottom level of the bridge deck has been set at 96.75 m, well above the maximum flood level recorded in 2014. The finished top level of the bridge deck has been set at 98.280 m, providing adequate additional freeboard above the flood level recorded during the 2014 event. This elevated deck configuration will effectively prevent overtopping and restricts floodwater ingress into the bridge superstructure.

Impacts

Improved Connectivity: The bridge provides a direct, all-weather link between Rohmoo, Pakherpora, Shopain, Anantnag, Kulgam, Yousmarg and Chariesharief reducing the travel time. Around

Economic Upliftment: Enhanced access to markets enables farmers and traders to transport produce efficiently, boosting incomes and local commerce.

Access to Services: Easier access to healthcare, education, and administrative services, particularly critical during emergencies and adverse weather.

Disaster Resilience: The bridge serves as a vital supply and rescue route during floods or other disasters, improving the region's emergency response capacity.

A lateral view of the newly constructed resilient Rohmoo Bridge at Pulwama.

A view of the Rohmoo Bridge superstructure showing the composite steel truss girder system, longitudinal girders, Bituminous top, and safety parapets

Approach Road of Rohmoo Bridge towards Rohmoo village

Approach Road of Rohmoo Bridge towards Pulwama side.

A view of 1.50m wide footpath on both sides of the Rohmoo bridge.

Views of crate walls constructed along the upstream and downstream reaches of the Rohmoo Bridge, demonstrating the use of crate structures for effective riverbank stabilization and slope protection.

3.4 Waachi Bridge, Shopian:

Design and Construction of 1x45 meter Trussed Girder Bridge Over Rambiara Nallah at Wachi, including Construction of Approach Roads and Nallah Training Works in District Shopian, J&K.

3.4.1 INTRODUCTION AND PRE-EXISTING CONDITION

The Waachi Bridge, stands as a critical infrastructure intervention under the World Bank-funded Jhelum Tawi Flood Recovery Project (JTFRP). This initiative was a direct response to the catastrophic floods of September 2014, which devastated large swathes of the Kashmir Valley, severely damaging public infrastructure, disrupting connectivity, and impeding socio-economic activities. The bridge was designed not only to replace the damaged infrastructure but also to incorporate disaster-resilient features, ensuring sustainability against future floods and earthquakes.

The Wachi bridge is located at Kumar Mohalla, Wachi, in Shopian Block of Shopian District, J&K. This area lies approximately 7 km east of the District Headquarters, Shopian, and about 46 km from the State Capital, Srinagar. Wachi is bounded by Kulgam Block to the east, Pulwama Block to the north, and Devsar and Qaimoh Blocks towards the eastern side. This bridge will provide a critical connectivity link between the twin districts of Pulwama and Shopian via the Wachi–Zainapora Road. The bridge was of strategic importance for the region, as it will significantly enhance accessibility and boost local economic activity by providing the shortest and most efficient link to the National Highway passing through Sangam, Bijbehara.

Pre-existing condition:

Prior to the new construction, the existing bridge at Wachi was a critical but aging wooden structure, which was unsafe and inadequate for modern transportation needs. Further, the temporary wooden crossing structure was highly vulnerable to hydrological extremes of the Rambirara stream and was frequently washed away during recurring flash flood events. During the September 2014 floods, when discharge in the Rambirara increased significantly, the makeshift wooden arrangement was completely overtopped and dismantled by the high-velocity floodwaters, severely disrupting connectivity and exposing the local population to safety risks and prolonged access constraints. This forced residents to take long detours, increasing travel time and costs, and posed severe risks during medical emergencies and adverse weather conditions. Despite repeated appeals and promises from authorities, reconstruction efforts were delayed due to funding constraints and administrative bottlenecks.

The persistent lack of reliable connectivity was not only hampering daily life but also stifled economic activity, especially for farmers and traders reliant on timely access to markets. The construction of a new, resilient bridge was thus a long-standing demand of the local population, underscored by repeated community mobilization and advocacy.

A view of the wooden footbridge constructed by local residents after the 2014 floods to facilitate temporary pedestrian connectivity across the Rambirara nallah in the absence of a permanent crossing.

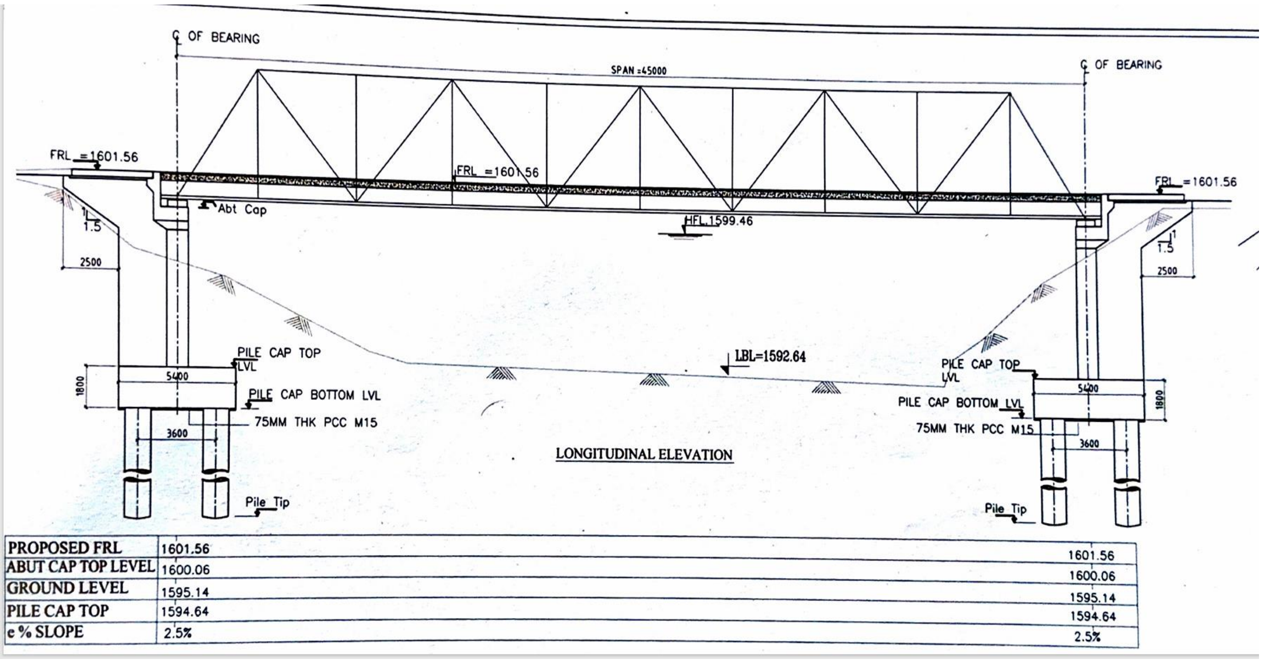
3.4.2 BRIDGE UPGRADE AND IMPROVEMENT

The Waachi Bridge is engineered to meet stringent safety, durability, and resilience standards, in line with both Indian and international codes.

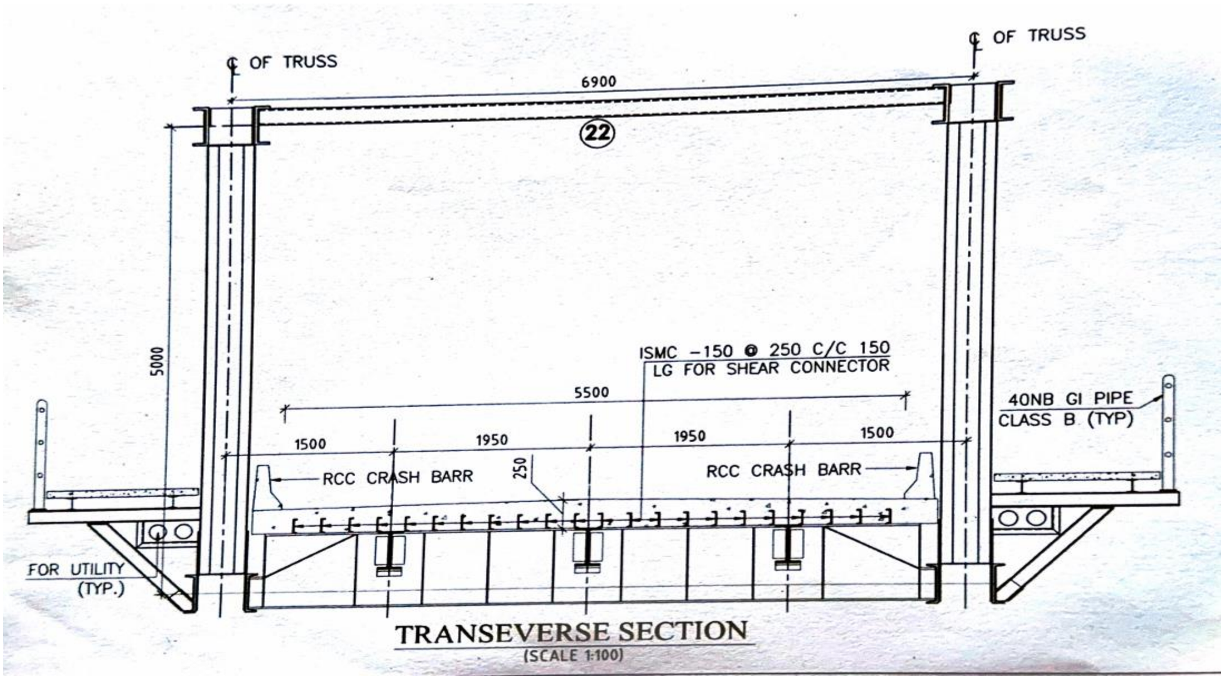
The Wachi bridge was constructed as a single span intermediate high level minor bridge of 45 mts span on Rambiara nallah in Shopian District of J&K. The bridge has the span configuration of 1x45 meters with open web girder superstructure laden with RCC composite deck slab. The bridge has a clear carriageway of 5.5 meters and a provision of 1.50m wide footpath on both sides of the bridge along with the provision to accommodate utilities especially PHE Pipes. The bridge is resting on both sides on RCC wall type abutment supported on pile foundations. There are eight no. RCC bored cast in situ piles at each abutment location having length of 25mts & 1.2 mts of dia. The pile cap thickness is 1.80 mts. The truss girder has the arrangement of warren with verticals having 6 mts height from centre of top chord to centre of bottom chord. The load transfer from superstructure to substructure has been ensured through Pot/PTFE of designed load capacity. The bridge’s design incorporates features to withstand both hydrological and seismic hazards, reflecting lessons learned from the 2014 disaster and subsequent vulnerability assessments.

Salient features of the Waachi Bridge, Shopian

S.No.	Item	Description
1.	Span Arrangement	1x45 meter
2.	No. of Spans	1
3.	Type of Bridge	High-Level Motorable Minor Bridge
4.	Substructure	RCC Wall Abutments with pile foundations
5.	Superstructure	Steel Trussed Girder with RCC Deck Slab compositely constructed
6.	Carriageway	Intermediate lane CW of 5.50 mts width
7.	Footpaths	1.50-meter Footpath on either side of CW.
8.	Bearing	POT/PTFE Bearings as per Design Load capacity
9.	Stream	Rambirara nallah/ stream.
10.	Approaches	- A total of 620-meter approaches on both sides was constructed with RCC/PCC approach wall. 600 m towards waachi side and 20 m towards Zainapora side
11.	Nallah Training Works	Wire Crate nallah protection works in several tiers both on U/S for 20 mts & D/S for 20 mts of the bridge.
12.	Expansion Joints	Strip Seal Type
13.	Elevated Deck Design	*The High Flood Level (HFL) at Waachi Bridge, Shopian as recorded during the 2014 floods, was 1599.46 m.* The bottom level of the bridge deck has been set at 1600.56 m, well above the maximum flood level recorded in 2014. The finished top level of the bridge deck has been set at 1601.56 m, providing adequate additional freeboard above the flood level recorded during the 2014 event. This elevated deck configuration will effectively prevent overtopping and restricts floodwater ingress into the bridge superstructure.



Longitudinal Section of Waachi Bridge



Transverse Section of Waachi Bridge

Impacts

Improved Connectivity: The bridge provides a direct, all-weather link between Kumar Mohalla, Dablepora, and adjoining villages, reducing travel distance and time to the Shopian district headquarters and National Highway 44. The bridge is expected to benefit approximately 11,442 people by improving connectivity and access.

Economic Upliftment: Enhanced access to markets enables farmers and traders to transport produce efficiently, boosting incomes and local commerce.

Access to Services: Easier access to healthcare, education, and administrative services, particularly critical during emergencies and adverse weather.

Disaster Resilience: The bridge serves as a vital supply and rescue route during floods or other disasters, improving the region's emergency response capacity.

Regional Integration: The bridge strengthens connectivity between Pulwama and Shopian districts via the Wachi-Zainapora Road, facilitating inter-district mobility and economic integration.

A lateral view of the newly constructed Waach Bridge at Shopian

A view of the Approach Road of the Waachi bridge towards the Zainapora side

A View of the Approach Roads of the Waachi Bridge

A Views of the Approach Roads of the Waachi Bridge towards the Waachi village side.

A view of the 1.50 m wide footpaths constructed on both sides of the Wachi Bridge.

A view of the Waachi Bridge superstructure showing the composite steel truss girder system, longitudinal girders, Bituminous top, and safety parapets.

View of stone pitching at Waachi Bridge, showcasing the hand-placed stone revetment along embankment slopes for effective erosion control, scour resistance, and long-term slope stabilization against high-velocity stream flows.

3.5 Chambgund Bridge, Kulgam

Design and Construction of 400-meter Span Trussed Girder Bridge on Vishav Nallah at Kulgam-Chambgund Road in District Kulgam, J&K.

3.5.1 INTRODUCTION AND PRE-EXISTING CONDITION

The Chambgund Bridge in Kulgam district represents a pivotal infrastructure development under the World Bank-funded Jhelum and Tawi Flood Recovery Project (JTFRP), designed to enhance connectivity and disaster resilience in Jammu and Kashmir. This sub-project involves the design and construction of a double-lane trussed girder bridge having 10 spans of 40 meters each (10x40 m) across the Vishav Nallah at Kulgam-Chambgund Road, Kulgam District, Jammu & Kashmir.

This bridge at Chambgund is a major/vital connecting link between Kulgam, D.H. Pora, D.K. Marg, Manzgam, Pahloo, Gasi raina, Arigutoo, Khulora, Gasrun, and Chitripora besides connecting district headquarter of Anantnag, Pulwama, and Shopian. The bridge was constructed on Chambgund-Kulgam Road connecting vast area to NH 44. The bridge will also serve indirectly to thousands of other souls of the other adjoining areas as it links these areas with National Highway and district head-quarter.

Pre-existing Conditions at the Chambgund Bridge Site

The Chambgund village, located in Kulgam District, was previously connected by a temporary causeway structure across the Vishav Nallah. This facility consisted of an elevated approach roadway constructed with compacted earth fill, granular sub-base, and stone aggregates, linking two existing reinforced concrete bridge segments, each 50 meters in length, situated on either bank of the stream. During the 2014 flood event, these two bridge portions experienced significant structural distress due to severe hydraulic forces, while the central causeway section was completely washed away. The loss of this critical crossing disrupted connectivity to adjoining settlements and adversely affected local mobility, access to essential services, and the transportation of agricultural produce. The continued absence of a reliable crossing at this location remains a major constraint for the community, underscoring the necessity for a permanent, all-weather, and flood-resilient bridge structure. This infrastructure arrangement was fundamentally unsustainable for several critical reasons:

Seasonal Disconnectivity Crisis - The causeway-based approach became completely impassable during the rainy season and monsoon months, isolating Chambgund village from Kulgam district headquarters and adjoining areas. This created severe hardships to the school going children faced irregular attendance, patients requiring medical care could not access district hospitals, and farmers were unable to transport agricultural produce to markets during peak season when prices were favorable.

Structural Vulnerabilities - The pre-existing causeway was designed at or near the flood level of Vishav Nallah, creating multiple vulnerabilities:

Inadequate waterway opening for flood discharge, Frequent overtopping during monsoon periods, Severe erosion and scouring of the approach road during flood events, Deterioration of causeway materials due to repeated submergence, undermining of bridge abutments and protection works. These issues required constant, costly repairs after every significant rainfall a reactive maintenance cycle that could never fully resolve the underlying structural inadequacy.

Flood Disaster Impact - The catastrophic September 2014 floods dramatically exposed these vulnerabilities. During September 2-6, 2014, torrential rainfall caused unprecedented flooding across Jammu & Kashmir:

During this extreme flood event, the Vishav Nallah recorded a maximum calculated discharge of 946.75 cumecs. The existing temporary bridge at Chambgund suffered severe structural damage, resulting in complete loss of connectivity for Chambgund village and surrounding habitations for extended periods, exacerbating access challenges and relief efforts.

Prior to the construction of the new Chambgund Bridge, the site presented significant challenges due to the absence of robust and reliable infrastructure over the Vishav Nallah. The Vishav Nallah is a major tributary of the Jhelum River, and its crossing at Kulgam-Chambgund Road was a point of considerable vulnerability and inconvenience. Local communities faced severe transportation difficulties, particularly during periods of heavy rainfall and subsequent flooding. The pre-existing condition contributed to unreliable connectivity, which hindered daily movement, limited access to essential services, and impeded emergency responses.

The region of Kulgam district is historically prone to floods, and the 2014 floods further exacerbated the need for resilient infrastructure. The lack of a durable crossing meant that communities were often isolated, impacting economic activities and overall quality of life. The project was identified as crucial for flood recovery and resilience, aiming to mitigate these recurrent issues and provide dependable, all-weather access. Local residents experienced persistent difficulties due to damaged roads and the unreliable crossing, leading to appeals for immediate infrastructural improvements.

A view of the pre-existing causeway prior to the construction of the resilient Chambgund Bridge at Kulgam.

A surviving span of the Chambgund bridge over the Veshaw Nallah, which remained intact and structurally resilient during the devastating September 2014 floods, while the adjoining temporary causeway was completely washed away.

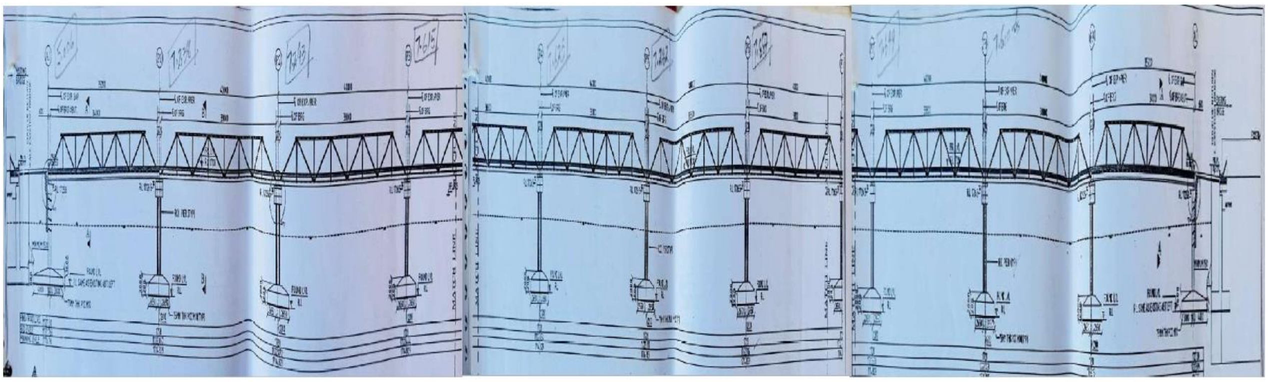
A view of the newly constructed, resilient Chambgund Bridge at Kulgam, spanning the Veshaw Nallah under the JTFRP.

3.5.2 BRIDGE UPGRADE AND IMPROVEMENT

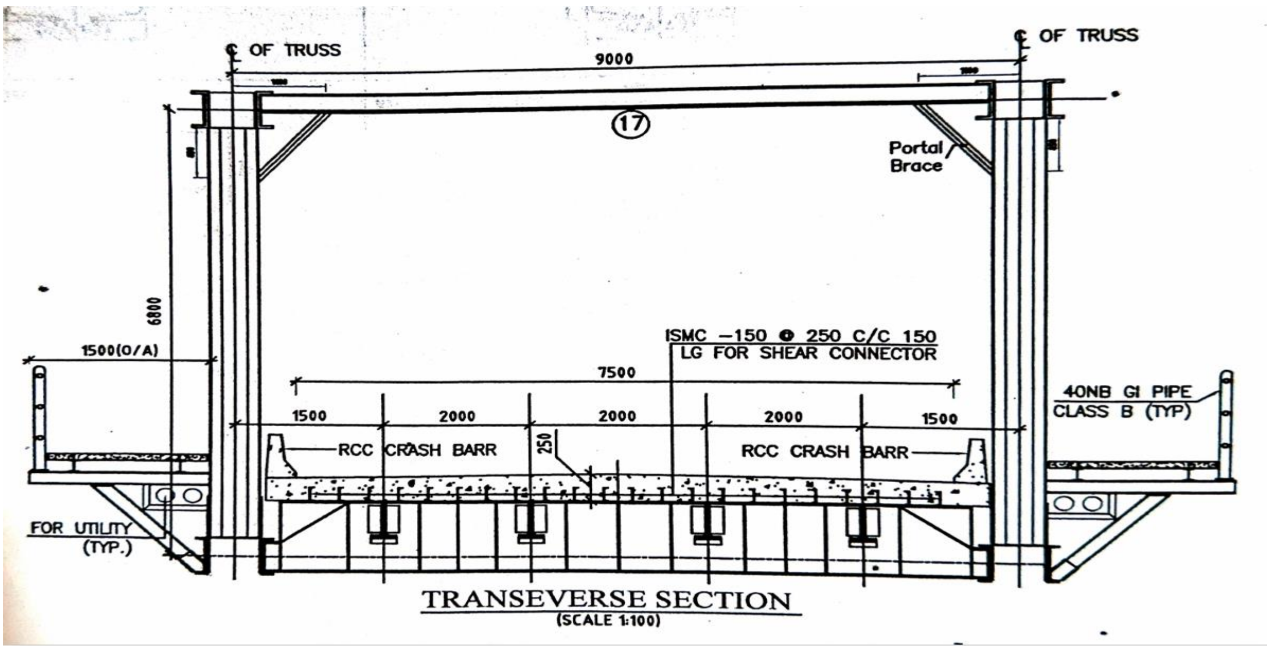
The Chambgund Bridge was specifically designed as a 400-meter span trussed girder bridge over the Vishav Nallah at Kulgam-Chambgund Road in District Kulgam, J&K. This design choice reflects a commitment to durability and high load-bearing capacity, particularly important given the region's flood-prone environment. The bridge is a two-lane structure, providing improved transportation efficiency and safety for commuters.

The bridge has the span configuration of 10x40 mts with open web girder superstructure laden with RCC composite deck slab. The bridge has a clear carriageway of 7.50 mts and a provision of 1.50m wide footpath on both side of the bridge along with the provision to accommodate utilities especially fresh water Pipes. The end spans, each measuring 40 m, rest on RCC wall-type abutments. The inner eight spans are resting on both ends on RCC wall type piers having circular ends. The truss girder has the arrangement of warren with verticals having 6 mts height from centre of top chord to centre of bottom chord. Both RCC Wall type Abutment as well as Wall type Piers are resting on open foundations. The load transfer from superstructure to substructure has been ensured through Pot/PTFE bearings of designed load capacity.

It is pertinent to note that the newly constructed Chambgund Bridge has a total length of 500 m, of which the central 400 m span has been reconstructed under JTFRP. The existing 50 m reinforced concrete approach spans at both ends were retained, based on the assessment of the R&B Department confirming that these segments remained structurally sound and fit for continued service. From the perspective of the World Bank's disaster and climate resilient transport guidance and "build back better" principles, full replacement of the entire 500 m bridge would have offered the highest degree of hydraulic performance, geometric uniformity, and resilience to future flood events. Notwithstanding this design constraint, robust structural integration measures were implemented by securely tying the new bridge foundations to the existing abutments, and providing rock-filled concrete protection at these interfaces using graded rock aggregates encased in high-strength concrete to improve scour resistance, structural stability, and long-term durability against the erosive action of the Vishav Nallah.



Longitudinal section of Chambgung Bridge



Transverse section of Chambgung Bridge

Salient features of the Chambgund Bridge, Kulgam

S.No.	Item	Description
1.	Span Arrangement	10x40 mts. Total length of 400mts end to end between existing bridges.
2.	No. of Spans	10 Spans overall with end spans provided in grade
3.	Type of Bridge	High-Level Motorable Major Bridge
4.	Substructure	RCC Wall Abutments with open foundations RCC Wall type Piers with open foundations
5.	Superstructure	Steel Truss Girder with RCC Deck Slab compositely constructed
6.	Carriageway	Double Lane CW of 7.50 mts width
7.	Footpaths	1.50 mts Footpath on either side of CW.
8.	Bearing	POT/PTFE Bearings as per Design Load capacity
9.	Stream	Vishav nallah (tributary of the River Jhelum)
10.	Approaches	Approaches not part of contract
11.	Nallah Training Works	Wire crated nallah protection works in several tiers both on U/S for 200 mts & D/S for 100 mts of the bridge
12.	Expansion Joints	Strip Seal Type
13.	Elevated Deck Design	*The High Flood Level (HFL) at Chambgund Bridge, Kulgam as recorded during the 2014 floods, was 1725.00 m.* The bottom level of the bridge deck has been set at 1727.00 m, well above the maximum flood level recorded in 2014. The finished top level of the bridge deck has been set at 1728.00 m, providing adequate additional freeboard above the flood level recorded during the 2014 event. This elevated deck configuration will effectively prevent overtopping and restricts floodwater ingress into the bridge superstructure.

Impacts:

The completion of the Chambgund Bridge has brought about significant and positive impacts on transportation connectivity, local economic activity, access to essential services, and overall disaster resilience in the Kulgam district.

All-Weather Access: The bridge provides crucial all-weather connectivity between several villages in Block Devsar and the district headquarters, a significant improvement over the previously unreliable and flood-vulnerable crossings. This has eliminated disruptions caused by seasonal flooding, ensuring continuous movement of people and goods.

Enhanced Safety: The robust design of the steel trussed girder bridge has replaced hazardous crossings, contributing to a marked improvement in public safety for commuters and pedestrians.

Reduced Travel Times: Daily commutes have become safer and more efficient, reducing travel times for residents. This is particularly beneficial for school-going children and the elderly, who previously faced considerable difficulties and hazards.

Economic Boost: Improved connectivity facilitates the efficient movement of goods and services, stimulating local economic activity. Traders can access markets more easily, and businesses benefit from a more reliable supply chain.

Long-term Resilience: The design, incorporating international best practices for resisting flood and seismic forces, ensures the bridge's longevity and its role in the region's long-term disaster resilience strategy.

Socio-economic Upliftment: The overall socio-economic conditions of the community have been uplifted through improved access and opportunities. The project benefits over 216771 people with improved access to roads and bridges across the region.

A lateral view of the completed Chambgund Bridge at Kulgam.

A view of the newly constructed Chambgund Bridge's superstructure

A view of the Chambgund Bridge superstructure showing the composite steel truss girder system, longitudinal girders, Bituminous top, and safety parapets

A view of 1.50m wide footpath on both sides of the Chambgund bridge, Kulgam

Views of crate walls constructed along the upstream and downstream extents of the Chambgund Bridge, illustrating the application of crate structures for effective riverbank stabilization and slope protection.

View of the newly constructed Chambgund Bridge seamlessly integrating with the remnant portion of the existing old bridge structure, illustrating the strategic alignment and connection methodology to maintain continuity of the roadway alignment while enhancing overall load-carrying capacity and hydraulic efficiency across the Vishav Nallah.

View of rock-filled concrete protection applied to the existing bridge foundation at the abutment location, demonstrating the use of graded rock aggregates encased in high-strength concrete for enhanced scour resistance, structural reinforcement, and long-term protection against the erosive forces of the Vishav Nallah.

3.6 Kaliban Bridge, Baramulla

Design and Construction of 1x25 meter Plate Girder Bridge on Raine Nallah at Kaliban, including Construction of Approach Roads and Nallah Training Works in District Baramulla, J&K.

3.6.1 INTRODUCTION AND PRE-EXISTING CONDITION

The 1x25 meter single-span plate girder bridge at Kaliban represents a critical infrastructure recovery initiative under the World Bank-funded Jhelum and Tawi Flood Recovery Project (JTFRP). Located in Kaliban village (Sheern Abad) in Narwav Block, District Baramulla, J&K this sub-project was developed in response to the devastating September 2014 floods that caused catastrophic damage across the region, including complete destruction of existing bridge structures over Raine Nallah. The bridge was designed and constructed with enhanced resilience features to withstand both earthquake and flood forces in accordance with the latest official design guidelines, reflecting the state's vulnerability to these dual hazards.

The constructed Kaliban bridge addressed a critical connectivity gap affecting around 4929 residents across multiple villages including Kaliban, Beigh/Qureshi Mohalla, Batmohalla, Chek, Pakthoon Mohalla, Asthan Mohalla, Chamri Mohalla, Sheikh Mohalla, and Mughal Mohalla.

The new motorable bridge serves multiple critical functions: restoration of all-weather connectivity, improved access to markets thereby increasing economic growth, timely access to health and education services, and provision of supply and rescue routes during future disaster events.

Pre-Existing Condition

Prior to the 2014 floods, a permanent motorable bridge existed across Raine Nallah, providing vital connectivity between adjoining habitations and facilitating the movement of people, goods, and essential services. This bridge played a crucial role in the socio-economic integration of the surrounding areas.

However, the 2014 flood disaster completely washed away the existing bridge infrastructure, rendering the crossing unusable. The extent of damage was total, leaving no scope for rehabilitation and thereby necessitating reconstruction of a new bridge structure.

In the aftermath of the floods, and in the absence of any permanent crossing, local residents improvised by constructing a temporary wooden footbridge to cross the stream. While this arrangement provided minimal pedestrian access, it was non-motorable, structurally fragile, and unsafe, particularly during adverse weather conditions and high-flow periods.

The absence of a proper motorable bridge caused severe hardships to the local population and residents of adjoining areas. Vehicular movement was completely restricted, adversely affecting access to healthcare facilities, educational institutions, markets, emergency services, and administrative centers. The temporary wooden bridge further aggravated the situation, as it could not support vehicular traffic, livestock movement, or the transport of construction materials and agricultural produce, thereby intensifying the socio-economic distress of the region.

Accordingly, the construction of a permanent, all-weather motorable bridge at this location was essential to restore connectivity, ensure public safety, and support sustainable development of the area.

A temporary wooden footbridge was constructed by local residents at the Kaliban Bridge site following the 2014 floods to facilitate stream crossing in the absence of permanent connectivity infrastructure.

3.6.2 BRIDGE UPDRADE AND IMPROVEMENT

Bridge Type and Span Configuration: The bridge structure was constructed as a single-span plate girder bridge with a total span of 1x25 meters. The plate girder type represents a cost-effective and durable solution for medium-span applications, utilizing built-up steel sections comprising top and bottom flange plates welded to web plates

Single-Lane Configuration: The bridge accommodates single-lane vehicular traffic with appropriate width standards for rural connectivity, consistent with IRC specifications for rural roads. This single-lane design is appropriate for the local context while maintaining structural efficiency.

Structural System: As a plate girder bridge, the superstructure comprises composite design with reinforced concrete deck slab composite action with steel plate girders. This composite system optimizes material utilization and provides enhanced load-carrying capacity compared to non-composite designs.

Hydrological and Geotechnical Considerations

The Raine Nallah represents a dynamic water channel with significant flood potential, as evidenced by the 2014 disaster. The design was accounted for extreme flood conditions characterized by:

High-Velocity Flow: Protection around bridge abutments required advanced design using appropriate techniques capable of withstanding devastating floods.

Channel Dynamics: Proper nallah training works protect the channel against erosion and instability.

Substructure Design

Foundation Type: Open trench foundation was typically employed for this bridge, with design depths determined by scour analysis and bearing capacity requirements. The foundation was extended below maximum scour depth to ensure stability during extreme flood events.

Abutment Design: RCC cantilever abutments were designed with appropriate return wing walls and protection measures. The cantilever configuration transfers bridge loads through the abutment stem to the foundation, with careful consideration of:

- Backfill pressure and stability
- Lateral earth pressure calculations
- Scour protection with stone pitching or similar durable techniques

- Drainage provisions to prevent uplift pressure
- Seismic resistance through appropriate reinforcement detailing

Bearing and Expansion Provision: The single-span configuration minimizes complex bearing requirements but includes appropriate elastomeric bearings or fixed bearings as per design requirements, with provision for thermal expansion and contraction.

Superstructure Design

Deck Slab: Reinforced concrete deck slab composite with steel girders provides load distribution and wearing surface. Design included:

- Reinforcement in both directions (primary and distribution bars)
- Wearing coat for surface protection
- Proper slope for drainage

Steel Girders: Plate girder design as per IRC:24 specifications included:

- Built-up plate sections with welded construction
- Web stiffeners to prevent shear buckling
- Flange sizing for positive and negative moment regions
- Camber provisions for deflection control
- Diaphragms and cross-frames for lateral stability

Seismic Factor in Design Bridge

The bridge site at Kaliban on Raine Nallah in Baramulla District is located in Seismic Zone V and prone to high-intensity earthquakes. While designing of bridge components, suitable seismic load factor was taken into consideration.

Snow Load on Proposed Bridge Site

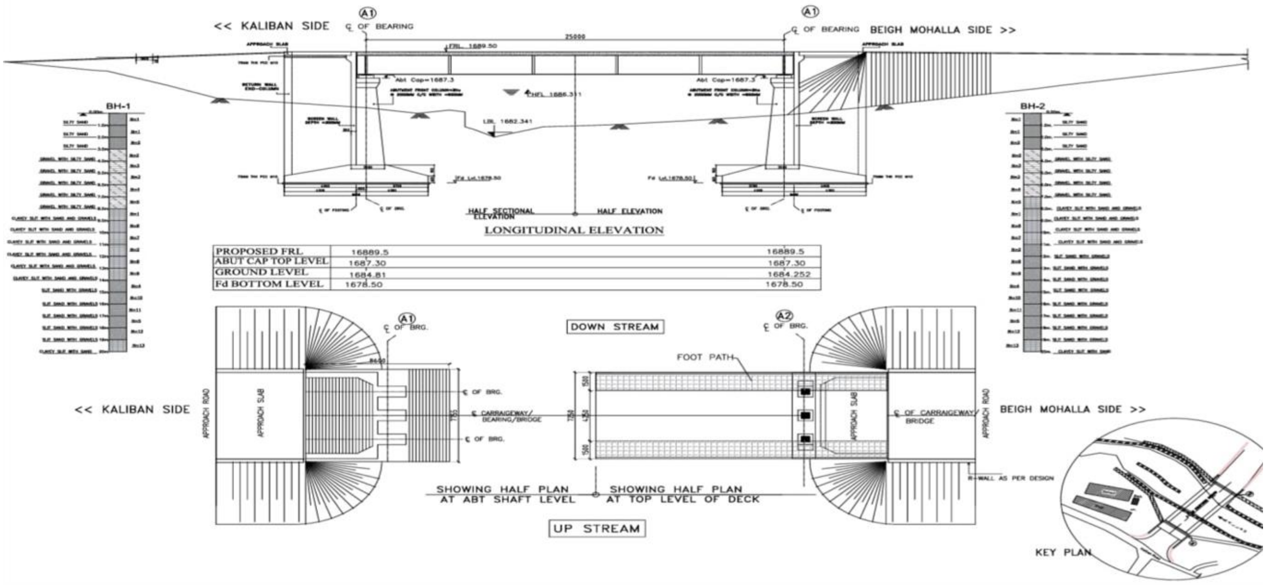
The 1x25 meter bridge at Kaliban in Baramulla District receives heavy snowfall which normally occurs during extreme winter. The design team has considered the design parameters based on the snow load and included in the design aspects.

Nallah Training and Protection Works

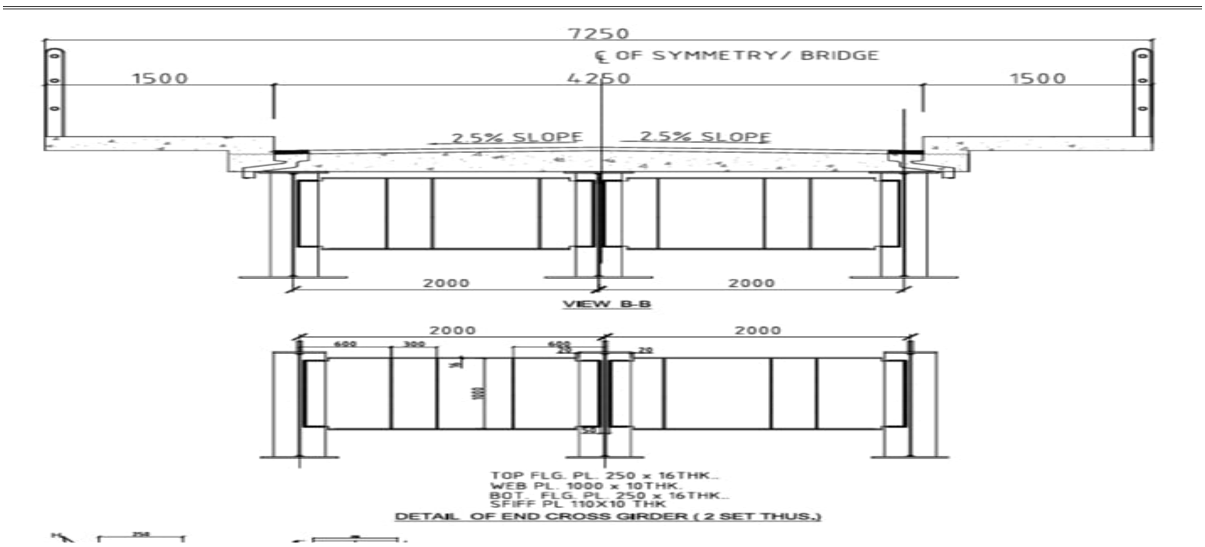
Nallah training works for Raine Nallah was critical to protect the bridge, its foundations, and approach roads from the stream's dynamic and erosive forces. A total of 200 meters of Crate wall was constructed along the upstream and downstream reaches of the bridge to ensure adequate protection and channel stability.

Pavement upgrades:

The Approach Road surface was upgraded with 50mm thick Bituminous Macadam (BM) and 25mm Open Graded Premix Carpet (OGP). A total length of 50 meters of approach roads on both sides was constructed with RCC retaining/protection walls. This upgrade ensures a high-quality, smooth riding surface with enhanced durability, making the approaches resilient to traffic loads and harsh weather conditions, thereby improving overall safety and serviceability of the bridge.



Longitudinal Section of Kaliban Bridge



Transverse Section of Kaliban Bridge

Salient Features of the Kaliban Bridge, Baramulla

S.No.	Item	Description
1.	Span Arrangement	1x25 meter
2.	No. of Spans	1
3.	Type of Bridge	High-Level Motorable Minor Bridge
4.	Substructure	RCC Wall Abutments with open foundations
5.	Superstructure	Composite Plate Girder
6.	Carriageway	Single lane CW of 4.25 mts width
7.	Footpaths	1.50-meter Footpath on either side of CW.
8.	Bearing	Elastomeric Bearings as per Design Load capacity
9.	Stream	Raine nallah/ stream
10.	Approaches	- A total of 50-meter approaches on both sides of the bridge was constructed with RCC approach wall
11.	Nallah Training Works	Wire Crate nallah protection works in several tiers both or for 150 mts & D/S for 50 mts of the bridge.
12.	Expansion Joint	Strip Seal type
13.	Elevated Deck Design	*The High Flood Level (HFL) at Kaliban Bridge, Baramulla as recorded during the 2014 floods, was 1686.311 m.* The bottom level of the bridge deck has been set at 1687.80 m, well above the maximum flood level recorded in 2014. The finished top level of the bridge deck has been set at 1689.50 m, providing adequate additional freeboard above the flood level recorded during the 2014 event. This elevated deck configuration will effectively prevent overtopping and restricts floodwater ingress into the bridge superstructure.

Impacts

The completed bridge will deliver significant benefits:

- Connectivity: Direct connection of Kaliban village with adjoining areas, improving accessibility.
- Economic Growth: Enhanced market access for local products and agricultural output
- Social Services: Improved access to healthcare facilities and educational institutions
- Disaster Resilience: Designed infrastructure capable of withstanding extreme floods and earthquakes
- Community Development: Approximately 4929 residents will benefit from this improved connectivity.

A Lateral view of the completed Kaliban Bridge at Baramulla

A view of the Kaliban Bridge superstructure showing the carriage way with Bituminous to beam with railing guard.

A view of Approach Road of Kaliban Bridge.

A view of Approach Road of Kaliban Bridge.

Views of Approach Roads leading to the Kaliban Bridge at Baramulla.

Views of crate walls constructed along the upstream and downstream extents of the Kaliban Bridge, illustrating the application of crate structures for effective riverbank stabilization and slope protection.

3.7 Trenz Bridge, Shopian

Design and Construction of 6x50 meter Span Double Lane Trussed Girder Bridge at Trenz Sheikhpora over Rambiara Nallah in Shopian District (J&K) including construction of Approach Roads and Nallah Training work.

3.7.1 INTRODUCTION AND PRE-EXISTING CONDITIONS

The Trenz Bridge Subproject, implemented under the World Bank-funded Jhelum Tawi Flood Recovery Project (JTFRP), involves the design and construction of a double-lane trussed girder bridge having six spans of 50 meters each (6x50 m) across the Rambiara Nallah at Trenz Sheikhpora, Shopian District, Jammu & Kashmir. The scope of work further encompasses the construction of approach roads on both abutments and the execution of comprehensive nallah training and protection works to ensure the structural integrity, hydraulic efficiency, and long-term sustainability of the bridge and its adjoining infrastructure.

The Trenz Bridge in Shopian, Jammu and Kashmir, stands as a critical infrastructure project implemented under the World Bank-funded Jhelum and Tawi Flood Recovery Project (JTFRP). This 300-meter-long steel truss girder bridge, located over the Rambiara Nallah at Trenz village, is a testament to post-disaster reconstruction efforts aimed at enhancing regional connectivity and fostering socio-economic development. Its construction addresses a decade-long need for a resilient crossing after the original bridge was swept away by the devastating floods of 2014.

Heavy continuous rainfall triggered extreme flooding in Rambiara Nallah, a flood-prone waterway in a plain valley near Trenz Sheikhpora. The existing structure a causeway-Bailey bridge could not withstand the high-water discharge and hydraulic forces, resulting in its total washout. The bridge's failure severed connectivity between Shopian and villages in Pulwama, Kulgam, and areas like Trenz, Mohanpora, Dangerpora, Imam Sahib, Sheikhpora, Arihal, Ahagam, Peerpora, and Arigam. Residents and horticulture-dependent communities (apples, walnuts) faced severe hardships transporting produce to markets without all-weather access, exacerbating economic losses in a region already hit by the disaster affecting millions statewide.

The earlier crossing at the Trenz Bridge site consisted of a composite arrangement of temporary Bailey bridge spans and low-level causeways constructed across the Rambirara stream. The total active river corridor at this location measures approximately 350 m in width. Under normal hydrological conditions, the active flow channel is confined to the central portion of about 200 m, while the remaining floodplain zones on either side remain largely dry for most of the year.

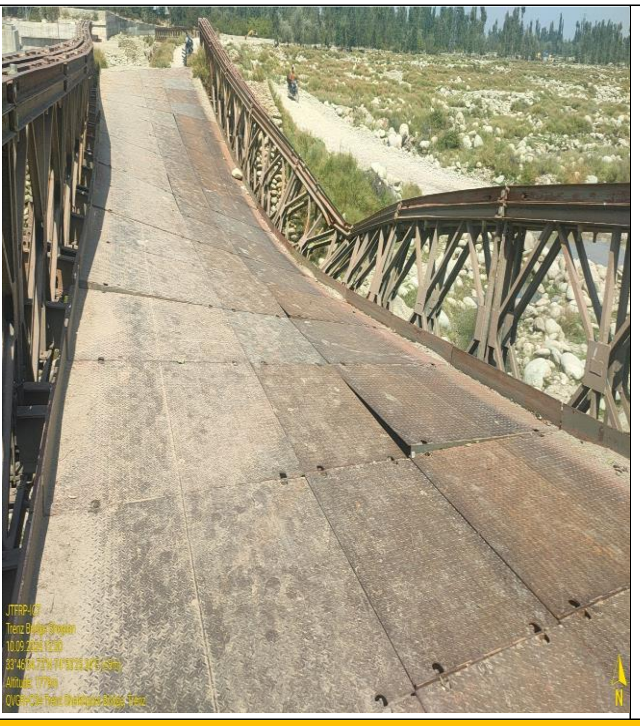
In view of this flow pattern, the central active channel was provided with two short-span Bailey bridges, whereas the balance stretch was traversed through earthen and paved causeways constructed at or near the riverbed level. These causeways functioned as low-water crossings, allowing vehicular and pedestrian movement during lean flow periods.

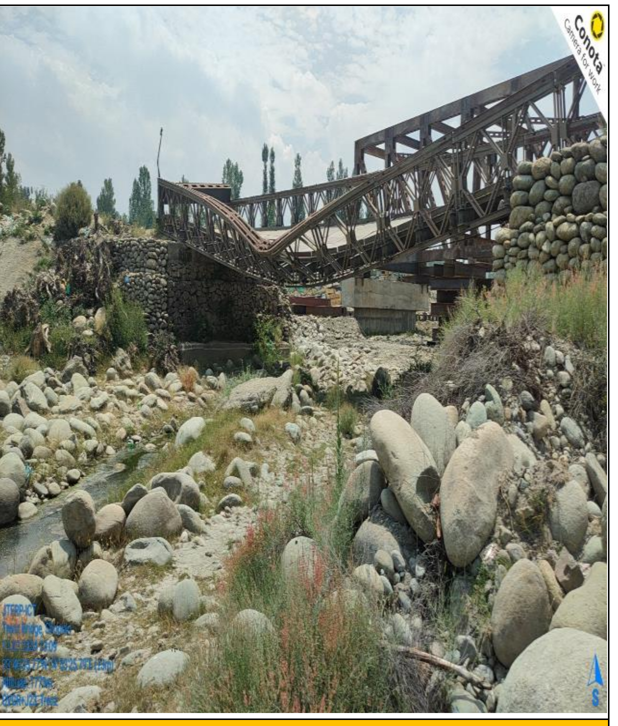
However, during high-intensity rainfall events and flash floods, the Rambiara stream exhibits a rapid increase in discharge, resulting in lateral spread of floodwaters across the entire 350 m width. Under such conditions, the low-level causeways were routinely overtopped, rendering the crossing non-operational and unsafe. Simultaneously, the Bailey bridge spans were subjected to high flow velocities, increased hydraulic pressure, debris impact, and severe scour around foundations and abutments, leading to repeated structural distress and partial failures.

The combined Bailey and causeway configuration, though adequate as a temporary arrangement under normal flow conditions, lacked hydraulic adequacy, flood resilience, and long-term structural stability for a flashy and morphologically active stream such as Rambiara. Consequently, the arrangement resulted in frequent service disruptions, recurring maintenance expenditure, and elevated safety risks, underscoring the need for a permanent, high-level, flood-resilient bridge structure designed to safely pass the design flood and ensure year-round connectivity.

A view of two short span bailey bridges that were existing before the construction of the new Trenz Bridge, Shopian

A view of the vented causeways that were existing during the construction of the new Trenz Bridge, Shopian





Photograph showing the damaged Bailey bridge at Trenz, affected by flash floods prior to the construction of the new resilient bridge.

3..7.2 BRIDGE UPGRADE AND IMPROVEMENT

The Trenz Bridge project at Shopian was implemented as a critical component of the regional infrastructure development program to enhance safety, functionality, and resilience of stream crossings and connecting routes. The sub-project addressed key challenges identified during preliminary assessments, including replacement and rehabilitation of the existing steel Bailey and causeway combo bridge structure, strengthening of foundations and abutments, improvement and widening of bridge approaches, and augmentation of drainage and protective works. These interventions ensure reliable all-weather connectivity, enhanced structural stability, and improved transportation efficiency across the Rambiara Stream, thereby supporting socio-economic development in the region.

Key technical specifications include:

Length and Type: This bridge was constructed as 300-meter-long (or 6x50 meter span) double-lane trussed girder bridge. The fabrication of steel trussed girders is a crucial component of its construction, including hoisting and placing for span No. 1 & 2 as the water flow near these spans was high.

Construction Materials: The structural steel used is Grade E-250, conforming to IS 2062 standards, ensuring strength and durability. Connections are made with 8.8 Grade HSFG nut bolts and all fabricated sections receive a coat of approved primer and enamel paint for protection against corrosion.

Safety Features: The bridge incorporates 50mm nominal bore GI pipes of medium grade as rails, complete with clamps and proper painting, adhering to technical specifications.

Wider Deck and Better Accessibility: The latest design includes a carriageway width of 7.5 meters along with 1.5-meter-wide footpaths on both sides, offering improved safety for pedestrians and vehicles alike. This is an upgrade from the narrower carriageway of the old structure.

Enhanced Load-Bearing and Safety Features: The new bridge is constructed using a robust combination of truss elements with girders, ensuring it can bear higher traffic loads and adverse weather conditions, addressing limitations of the old Bailey design.

Mitigation of Seismic and Flood Impacts: Geotechnical design enhancements that improve the geomatrix's resilience against lateral forces due to seismic activity or flood-induced soil liquefaction, thereby ensuring foundation stability under adverse conditions.

Modern Construction Materials and Techniques: Use of earthquake-resistant and corrosion-protected materials enhances durability and longevity, which was a challenge for the older steel Bailey bridge subjected to the region's harsh climate and floods.

Pavement upgrades:

The Approach Road surface was upgraded with 50mm thick Bituminous Macadam (BM) and 25mm Semi Dense Bituminous Concrete (SDBC). This upgrade provides high-quality smoothness and durability, making it resilient to traffic and harsh weather.

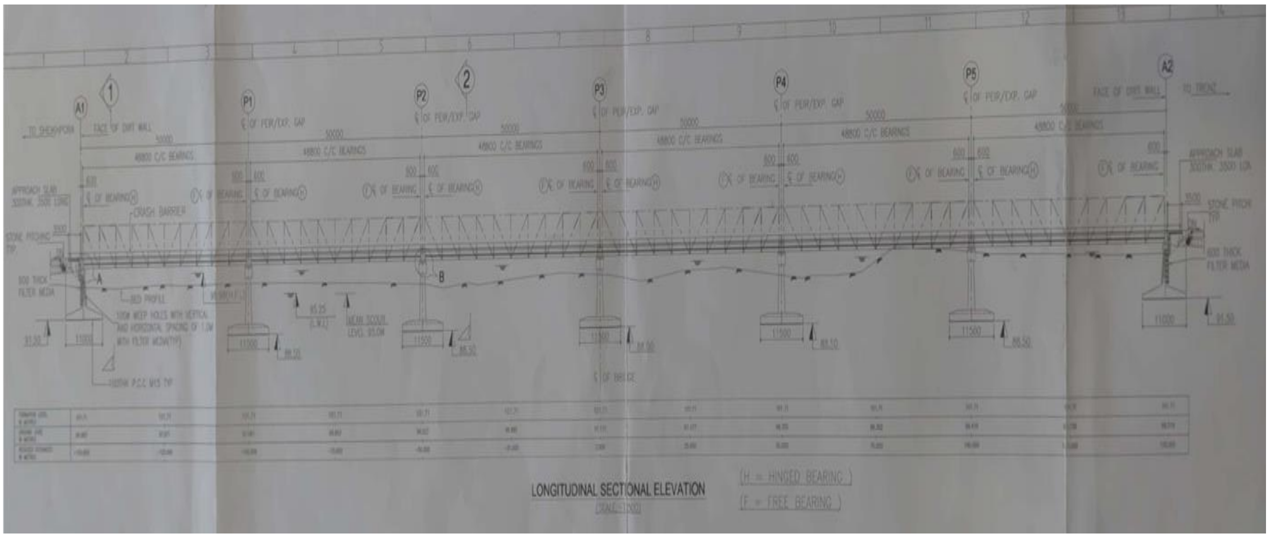
Improvement of cross drainage structures:

Multi barrel pipe culvert of 1200 mm diameter was installed at across the approach road towards Arihal side, having lengths of 15 m. The culvert was provided to improve water runoff management and facilitate the smooth passage of irrigation water across the road, thereby serving the adjoining paddy fields.

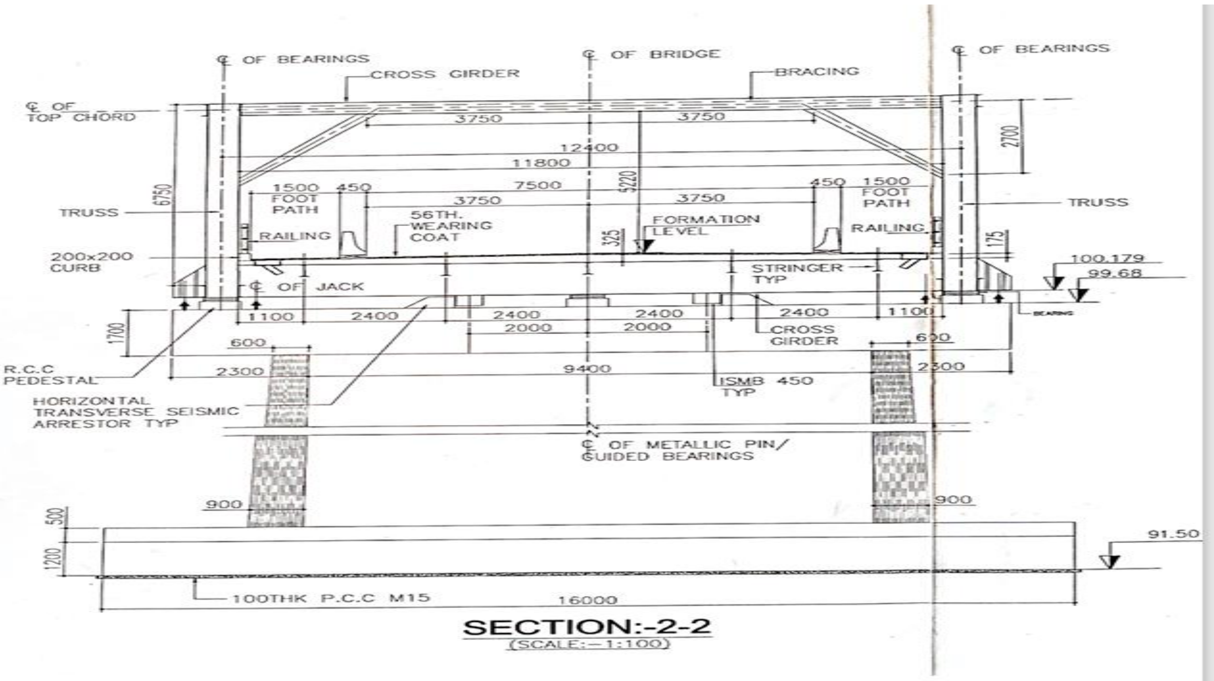
Additionally, RCC box culvert 2.5x2.5x10 m was constructed across the approach road towards Arihal side. The culvert was incorporated to facilitate unobstructed cross-drainage and to prevent waterlogging or surface runoff accumulation along the embankment.

Protection work:

A total of 642.6 meters of Crate walls were constructed at various sections along the upstream and downstream sides of the Trenz Bridge. This intervention was carried out to effectively mitigate soil erosion and prevent slope instability along the approach roads, thereby safeguarding the road infrastructure and enhancing the structural integrity of the adjacent bridge. The crate walls serve as a durable and environmentally sustainable erosion control measure, fully aligned with the project's environmental safeguard requirements.



Longitudinal section of Trenz Bridge, Shopian



Transverse section of Trenz Bridge, Shopian

Salient Features of Trenz Bridge, Shopian

S.No.	Item	Description
1.	Span Arrangement	6x50 meter
2.	No. of Spans	6
3.	Type of Bridge	Motorable Major Bridge
4.	Substructure	RCC Wall Abutments with open foundations RCC Wall type Pier with open foundations
5.	Superstructure	Steel Trussed Girder with RCC Deck Slab compositely Constructed
6.	Carriageway	Double lane CW of 7.50 mts width
7.	Footpaths	1.50-meter Footpath on either side of CW.
8.	Bearing	POT/PTFE Bearings as per Design Load capacity
9.	Stream	Rambirara stream
10.	Approaches	A total of 409-meter approaches on both sides was constructed with RCC retaining wall.
11.	Nallah Training Works	Wire Crate nallah protection works in several tiers both on U/S for 255 mts & D/S for 387.6 mts of the bridge.
12.	Expansion Joints	Strip Seal Type
13.	Elevated Deck Design	*The High Flood Level (HFL) at Trenz Bridge, Shopian as recorded during the 2014 floods, was 98.98 m.* The bottom level of the bridge deck has been set at 100.18 m, well above the maximum flood level recorded in 2014. The finished top level of the bridge deck has been set at 101.71 m, providing adequate additional freeboard above the flood level recorded during the 2014 event. This elevated deck configuration will effectively prevent overtopping and restricts floodwater ingress into the bridge superstructure.

Impact:

The new Trenz Bridge, rebuilt under the JTFRP, restores all-weather connectivity across Rambiara Nallah, linking Shopian District with Pulwama, Kulgam, and villages like Trenz, Mohanpora, and Sheikhpora.

Socio-Economic Benefits

Improved road access eases daily travel for 30,000 residents and boosts the local fruit trade, including apples and walnuts, by enabling faster transport to markets and cold storage facilities. This enhances economic activity, reduces post-harvest losses, and supports livelihoods in horticulture-dependent areas previously isolated after the 2014 floods.

Infrastructure Resilience

The double-lane trussed girder design will twithstand high flood discharges, minimizing future disruptions from Rambiara Nallah overflows and promoting regional disaster recovery.

Environmental Considerations

Culverts and nallah training work aid irrigation for paddy fields and runoff management, fostering agricultural sustainability.

The improved and uninterrupted connectivity provided by the new bridge will generate significant social and economic co-benefits, including better access to livelihood opportunities, continuity of educational and health services, and strengthened linkages of rural communities with the broader district road network. These outcomes are consistent with the development objectives of JTFRP, which seek not only to restore damaged infrastructure but also to enhance its performance, safety, and resilience to natural hazards through climate-informed, sustainable design and construction practices.

The project has undergone stringent quality checks covering environmental, civil, and mechanical domains as per World Bank and Indian standards for resilient infrastructure.

A lateral view of the completed Resilient Trenz Bridge at Shopian

A view of the Trenz Bridge superstructure showing the composite steel truss arch system, longitudinal girders, deck slab, cross-girders, Bituminous top, and safety parapets.

A view of Approach Road leading to the Trenz Bridge, Shopian

A view of Approach Road leading to the Trenz Bridge, Shopian

A view of Approach retaining wall with parapets

RCC box culvert constructed across the approach road of the Trenz Bridge on the Arihal side, facilitating unobstructed cross-drainage and preventing waterlogging or surface runoff accumulation along the embankment, and provided with wheel guards and safety railings.

Views of crate walls constructed along the bridge approaches, illustrating the use of gabion/crate structures for riverbank and slope protection.

3.8 Environmental and Safety Compliance for the Bridge Sub-Projects under JTFRP

During the construction of the Bridge sub-projects, all reasonable measures were undertaken to protect the environment, workers, and the surrounding community. The Environmental, Health, and Safety (EHS) measures prescribed in the respective Environmental Management Plans (EMPs) for the bridge sub-projects were rigorously implemented to ensure full compliance with applicable environmental regulations and safety standards.

The measures implemented during the construction phase of the Bridge sub-projects are as follows:

1. Environment and Safety officers (ESO) were appointed by the respective contractors for implementation of activities stated in the EMP, including occupation health and safety aspects.

2. Project information Board (Flex type) showing the name of work, project cost etc. were installed.

3. Workers were provided with necessary accommodations and ancillary facilities in functional and hygienic manner, as required.

4. Wherever feasible, unskilled and semi-skilled labourers from nearby communities were prioritized for employment to promote local livelihood opportunities and community participation.

5. To ensure public comfort and safety, site-specific traffic management plans were prepared by the contractor in coordination with the Employer and the Traffic Police. The transportation of construction materials, machinery, and waste to and from these sites was scheduled during non-peak hours to minimize traffic disruptions and public inconvenience.

6. Although the construction of Bridges did not require any Scheduled tree cutting, necessary precautions were taken to prevent damage to existing trees and vegetation in adjacent and off-site areas during project activities.

7. Workers were not allowed to defecate in the open. Proper toilets fitted with septic tank and with required hand-washing facility was provided by the Contractor at the construction site.

8. Solid waste generated at the construction site was collected in covered wasted bins. Polyethylene/plastic wastes were stored in empty cement bags and sent to authorized facilities for recycling.

9. Potable water facilities were provided at accessible locations within the construction site to ensure safe drinking water for all workers.

10. All necessary precautions were taken to protect and prevent any damage to existing structures around the bridge construction zones, including residential and commercial properties as well as access and haul roads.

11. All necessary measures were taken to avoid water logging during the execution of the work.

12. Temporary barricades were installed to clearly demarcate the construction zones, including material storage areas. The construction site and associated labour facilities were fully enclosed to prevent unauthorized entry and accidental trespassing by workers, staff, or the general public. Appropriate warning signage was displayed along access roads adjoining the sites to alert about the movement of construction vehicles and machinery.

13. All necessary measures to ensure the safety and health of workers were implemented throughout the execution phase. These included the provision and mandatory use of appropriate personal protective equipment (PPE); adoption of safety precautions during the demolition of existing structures and cleaning; availability of first-aid facilities with adequate sterilized dressings and appliances at work zones; safe storage of hazardous, toxic, and polluting materials; and strict adherence to electrical, fire, and mechanical safety protocols.

14. All vehicles, equipment, and machinery utilized for construction activities were regularly serviced and maintained in good working condition. The contractor ensured compliance by submitting valid Pollution Under Control (PUC) certificates for all vehicles, equipment, and machinery deployed on the project.

15. Roads used by vehicles of the contractor and suppliers were maintained in a clean condition, free from dust, mud, and other extraneous materials deposited by construction activities.

16. Measures were implemented to prevent contamination of surface water bodies and underlying aquifers from wastewater generated within the construction zone.

17. Cement bags were stored and handled within covered areas to minimize fugitive dust emissions.

18. Only diesel generator (DG) sets equipped with acoustic enclosures were permitted for use at the construction sites to control noise pollution.

20. Abandoned deep pits or boreholes at the Bridge construction sites were properly sealed to eliminate safety hazards.

21. Debris generated from the demolition of structures and other construction activities was segregated for reuse within the project or in other works. Residual debris and spoils were disposed of at locations pre-approved by the Engineer/Employer, in compliance with the Construction and Demolition Waste Management Rules, 2016, and in a manner that prevented environmental contamination.

22. Paint residues remaining in containers were appropriately stored and disposed of in an environmentally sound and compliant manner.

23. The construction of the bridges was carried out in a manner that did not alter the existing flow patterns or disrupt the surrounding drainage systems at the proposed sites. Flowing water was temporarily diverted using guide bunds and cofferdams at pier locations to facilitate safe and efficient construction.

24. To prevent water pollution at the bridge construction site, all construction vehicle parking locations, fuel/lubricants storage sites, vehicle, machinery and equipment maintenance and refuelling sites were located at least 250 m away from streams and irrigation canal/ponds.

25. Maintenance and servicing of all construction vehicles and machinery was carried out by contractor regularly to prevent Air and Noise pollution.

26. Both sides of the bridges were barricaded to delineate construction zone as well as material stacking areas by the contractor. The bridge construction sites were appropriately barricaded to prevent entry and accidental tress passing of workers, staff and others into the construction site. Proper retro-reflective warning signage were installed on the access road next to the construction site about the movement of construction machinery and vehicles.

27. The Contractors complied with all regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress at all the Bridge sites.

28. During rains/ snowfall, regular monitoring was carried for bridges & nallah protection works and scour protection work/ slope management. All incidents of erosion, deformation, and failure of protective works were promptly addressed through the implementation of appropriate corrective and preventive measures to effectively control and mitigate such issues.

The measures implemented during the Post Construction Phase of this sub-project are as follows:

1. Upon completion of the works and prior to handing over the bridges for use, the project sites were thoroughly cleaned. All waste materials and debris were removed and disposed of at designated locations pre-approved by the Engineer/Employer. The

Contractor undertook comprehensive cleanup and site restoration activities before demobilization, ensuring a safe, orderly, and environmentally compliant project closure.

2. All temporary structures erected during construction were dismantled and cleared from the Bridge sites.

3. All disposal pits and trenches were backfilled and properly sealed to eliminate potential safety or environmental risks.

4. The construction zones, including labour camps and other areas used or affected during project execution, were restored to a clean and orderly condition.

Approximately 568,349 people directly benefit from the successful completion of these sub-projects, with enhanced safety and resilience achieved through the provision of improved bridge infrastructure.

POST CONSTRUCTION COMPLIANCE OF BRIDGE SUB-PROJECTS

Clean-up Operations, Restoration and Rehabilitation

S No	Description	Yes/ No
1.	Whether Debris has been cleared from the roadside, and ground levelling has been carried out at all completed bridge sites.	Yes
2.	Whether all construction wastes from the campsite/ plant site have been removed and disposed of at the disposal site.	Yes
3.	Whether Stockyard restoration has been successfully executed.	Yes
4.	Whether all the Cement bags were removed from the site and disposed of at disposal site.	Yes
5.	Whether all disposal pits or trenches were filled in and effectively sealed off.	Yes
6.	Whether the contractor cleared all temporary structures, debris, construction wastes, garbage, night soils, etc in an environmentally sound manner.	Yes
7.	Whether the Surfaces were cleared of waste products from activities such as concreting or asphalting.	Yes
8.	Whether all streams within the bridge construction zones have been cleared of waste materials generated from activities such	Yes

	as excavation, concreting, and asphalting.	

Photographs: Environmental and Safety Compliance (Post Construction Phase)

A view of **Sadoora Bridge, Kulgam**. Whole bridge was cleared of the debris and the zone is looking clean and tidy.

A view of Approach Road of the Sadoora Bridge, Kulgam. Whole construction zone was cleared of the construction related waste. Parapet walls were installed wherever required for safety purpose.

A view of Bringi Stream from the constructed bridge Sadoora. Construction related and excavated waste were removed from the stream (post construction work).

A view of **Chambgund Bridge, Kulgam** post construction. All construction zone was clear construction related waste.

Footh Paths along the Chumbgund Bridge were also cleared of construction related waste

A view of Vishav Stream from the constructed Chamgund bridge. Stream was cleared of all Excavated and construction related waste during post construction phase.

A view of the **Wayil Bridge, Ganderbal** along with Foot paths. All areas of the bridge stands cleared of the construction waste material.

An angled view of the Wayil Bridge clearly depicts the clean Sindh River. Following the construction phase, the Sindh Stream was thoroughly cleared of all construction-related waste.

Irrigation channel flowing adjacent to the Approach Road of the Wayil Bridge was cleared of all the construction related waste.

An angled view of the **Trenz Bridge, Shopian** clearly depicts the clean Rambiara Stream. Following the construction phase, the Rambirara Stream was thoroughly cleared of all construction-related waste.

All existing causeway and Bailey bridge combinations at the Trenz Bridge site were dismantled and demolished in accordance with the Environmental Management Plan (EMP) guidelines as part of the post-construction activities.

A view of Approach Road of the Trenz Bridge, Shopian. Whole construction zone was cleared of the construction related waste. Parapet walls were installed wherever required for safety purpose.

An angled view of the **Rohmoo Bridge, Pulwama** clearly depicts the clean Romshi Stream. Following the construction phase, the Romshi Stream was thoroughly cleared of all construction-related waste.

A view of Romshi Stream from the constructed Rohmoo bridge. Stream was cleared of all Excavated and construction related waste during post construction phase.

Footh Paths along the Rohmoo Bridge were also cleared of construction related waste

An angled view of the **Kaliban Bridge, Baramulla** clearly depicts the clean Raine Nallah Stream. Following the construction phase, the Raine Stream was thoroughly cleared of all construction-related waste.

A view of Approach Road of the Kaliban Bridge, Baramulla. Whole construction zone was cleared of the construction related waste. Parapet walls were installed wherever required for safety purpose

Crate protection wall has been constructed along the Raine Nallah bank near the upstream and downstream of the Kaliban Bridge. This wall will control land sliding, erosion, and scouring on the stream banks during flood and high velocity of water in the stream.

A view of the **Waachi Bridge, Shopian**. All areas of the bridge stands cleared of the construction waste material.

A view of Approach Road of the Waachi Bridge, Shopian. Whole construction zone was cleared of the construction related waste.

Footpaths along the Waachi Bridge were also cleared of construction-related waste, ensuring a clean and safe environment for pedestrians.

3.9 Climate Resilience and Sustainability

The bridge designs implemented under the Jhelum Tawi Flood Recovery Project (JTFRP) incorporate targeted adaptations to the extreme climatic conditions prevalent in the Kashmir Valley.

- Snow Load Design: Compliant with IS 875 (Part 4)/IRC:6 for heavy snowfall regions.
- Corrosion Protection: To combat exposure to harsh climates and humidity, steel members were protected with galvanization or other specialized coatings to enhance durability and extend lifespan.
- Minimal Maintenance: Modern design reduces routine maintenance compared to temporary structures

4.0 Project Benefits and Resilience Outcomes

Improved Connectivity and Community Benefits

The bridge restores and enhances connectivity with these tangible benefits:

Education Access: Students can attend school regularly year-round without seasonal disruption, improving attendance and academic outcomes

Healthcare Access: Patients can reach respective district hospitals and specialist services within 30 minutes, compared to impossible access during monsoons previously.

Agricultural Productivity: Farmers can transport produce to markets reliably, capturing optimal pricing windows previously lost during flood seasons.

Economic Development: Commercial activity, skilled trades, and entrepreneurship can operate consistently without monsoon closures. Bridges connecting orchid horticulture lands now allow direct loading and supply of fruits from the fields, reducing additional labor and carriage to distant accessible points.

Population Beneficiaries: with the completion of these 07 essential bridges under the Jhelum Tawi Flood Recovery Project (JTFRP), approximately 1,005,456 people will directly benefit through enhanced regional connectivity, improved access to essential services, and greater resilience against future flood disruptions.

Resilience Metrics: The bridge achieves quantifiable resilience improvements.

Key needs addressed by these Bridge Sub-project:

1. Increase carriageway width and structural load capacity for modern vehicles.
2. Remedy structural deterioration and remove risk of sudden failure.

3. Improve resilience to seasonal floods, river scouring and extreme events.
4. Provide safer approaches, parapets, drainage and pedestrian access.
5. Reduce travel time and vehicle operating costs, supporting local commerce and access to services.
6. Enhancing road safety and reducing accident risk by replacing outdated or unsafe structures
7. Improving socio-economic outcomes by providing better access to health facilities, educational institutions, markets, and other key services.
8. Strengthening regional disaster response capacity by securing critical evacuation and relief routes in times of emergency.
9. The improved connectivity has boosted trade and tourism in the area. New shops and businesses have been established around the Bridges improved under the project, and bus services have increased.

Overall, the successful execution of these bridge subprojects under this initiative will play a pivotal role in supporting economic recovery, fostering inclusive growth, and building long-term resilience within the region's transport infrastructure

4.1 Over all Impacts

The construction of approximately 10 bridges across Kashmir Valley under the JTFRP (Jhelum Tawi Flood Recovery Project), funded by the World Bank, will have significant positive impacts on the region's socio-economic development, connectivity, resilience, and environmental sustainability:

Enhanced Connectivity and Accessibility

These bridges will drastically improve all-weather connectivity within the valley, linking remote and rural areas with urban centres. This will reduce travel times, facilitate smoother movement of goods, services, and people, and ease access to essential services such as healthcare, education, and markets. Enhanced connectivity will contribute to social inclusion and economic integration across the region.

Economic Growth and Livelihood Support

The improved infrastructure will stimulate local economies by enabling agricultural produce, handicrafts, and other goods to reach markets more efficiently. It will also encourage tourism development in scenic and culturally significant areas of Kashmir, supporting livelihoods and generating income opportunities for local communities.

Disaster Resilience and Flood Recovery

The bridges designed and constructed under JTFRP are engineered to withstand extreme flood events and adverse climatic conditions. Their robust construction will ensure continuity of connectivity even during natural disasters, thereby reducing vulnerability and aiding quick recovery post-disasters.

Environmental Safeguards and Sustainable Development

These projects incorporate environmental safeguards that include erosion control, proper drainage, and slope stabilization measures, minimizing adverse ecological impacts. The use of durable materials and advanced designs promotes sustainable infrastructure development that balances growth with environmental preservation.

Social and Regional Integration

By connecting dispersed communities, these bridges foster greater social cohesion and contribute to regional stability. Improved transport links can also enhance access for emergency response and security services, contributing to peace and security in a historically sensitive region.

4.2 Quality Assurance

The bridges were constructed under EPC (Engineering, Procurement, Construction) mode. Independent quality assurance was provided by Technical Assistance Quality Audit Consultant (TAQAC) ensuring:

- Material testing and certification compliance
- Structural monitoring during construction
- Design specification verification
- Occupational health and safety protocols

4.3 Lessons Learnt

1. The most significant design lesson was the effectiveness of integrating Flood and Seismic resilience requirements from initial conceptualization rather than addressing them sequentially. The elevated deck design inherently satisfied both flood overtopping prevention and regular maintenance access requirements, demonstrating how multi-hazard resilience can create elegant design synergies rather than competing requirements. Pin-guided and metallic-guided bearings were strategically installed to avert span unseating amid high-intensity seismic events, in meticulous adherence to Seismic Zone V stipulations.

Transferable Lesson - Future similar projects should establish comprehensive multi-hazard design matrices at the conceptual stage, defining all critical parameters (maximum flood discharge, scour depth, seismic zone intensity, snow/wind loads) before any detailed design work begins. This eliminates ambiguity and reduces contractor interpretation issues that generate Request for Information (RFI) and schedule delays.

2. Steel truss girder selection proved technically superior to solid plate girder alternatives for this application. The open-web truss configuration allows unobstructed

water flow during extreme floods. From inspection and maintenance perspective, open web geometry enables visual assessment of connection integrity and protective coating condition without requiring special access equipment.

For all future flood-prone water crossings, specifications should mandate open-web (truss) designs over solid plate girders. The marginal cost difference (typically 5-8% for steel tonnage) is justified by operational resilience benefits and extended service life.

3. The presence of dedicated Technical Assistance Quality Audit Consultant (TAQAC) oversight proved invaluable in maintaining construction standards and preventing sub-standard material incorporation. TAQAC functions site-level inspection, material testing, structural monitoring, and design compliance verification provided technical authority independent of contractor commercial interests. This is standard practice for World Bank projects and should become mandatory for all critical infrastructure.

4. The EPC contract model (Engineering, Procurement, Construction) provided single-point accountability for material sourcing and quality control. This approach proved superior to design-bid-build contracts where material procurement responsibility splits between designer expectations and contractor sourcing capabilities, often creating conflicts and delays.

5. Steel bridge construction requires specialized workforce skills in structural steel assembly, HSFG nuts & bolt torquing, field welding, and bearing installation capabilities requiring training investment beyond standard construction labor availability. The EPC contractor's prior experience with similar projects minimized learning curve, but local worker training requirements for future sustainability were identified.

6. Comprehensive waste management planning prevented debris spillage into respective streams that could have triggered environmental violations or secondary impacts. Excavated material from foundation work (boulders, gravel, sand) required designated disposal areas away from stream channels, with environmental monitoring per World Bank OP 4.01.

7. Community engagement during construction - advance public communication about schedule, grievance redressal mechanism establishment, local workforce participation prevented major community disruptions typical in sensitive post-disaster recovery contexts.

8. A clearly defined mandate and authority for the PMU is essential for decision making. Adequate staffing in PMU and PIUs must be ensured, with roles and responsibilities clearly assigned. Retaining trained staff for a minimum of 3 years helps maintain continuity and institutional memory. Capacity-building programs should be ongoing to adapt to technical and administrative complexities.

4.4 What More Could Have Been Done (Recommendations)

To improve future project outcomes in the design and construction phases, the following measures are recommended:

1. Continuous structural health monitoring through strategically located sensors would enable predictive maintenance and early warning of emerging distress. Early detection of bearing degradation, real-time flood impact assessment, seismic response documentation, and preventive maintenance scheduling would extend infrastructure life compared to reactive maintenance. It is recommended to install retrofit Health Monitoring System (HMS) capability at project completion with sensors at 5-8 critical locations (pier foundations, bearing locations, main truss mid-spans) for future projects.
2. Instead of relying solely on historical Highest Flood Levels (HFL), designs should explicitly model Climate Change Scenarios (e.g., 50-year or 100-year return periods with added margins) to determine soffit levels and scour depths.
   Current design for 2014 maximum discharges provides limited margin for projected climate changes. Precipitation projections for Kashmir Valley suggest 15-25% increase in extreme rainfall events by 2050, potentially saturating current design capacity within 20-30 years.
3. Structured training for government PWD/maintenance staff responsible for bridge operations ensures effective long-term stewardship.
4. Post-completion, bridges frequently deteriorate due to inadequate maintenance budgets despite government commitment to operations. It recommended to develop Financial Sustainability Plan at project completion, calculating annual maintenance requirements and securing government commitment to adequate funding.
5. Design permanent River Training Works (guide bunds) as part of the main bridge contract rather than treating them as ancillary protection works.
6. Contracts should mandate winter protection strategies (e.g., additives for concreting, covered workshops for fabrication) to allow some non-structural work to continue during lean months, preventing 4-5 month annual stoppages.

4.5 Conclusion: From Unsustainable Temporary Structures to Resilient Permanent Infrastructures

The Bridge Sub-projects implemented under JTFRP represents a fundamental transformation from an unsustainable, reactive temporary causeway structure to modern, proactive, resilient permanent infrastructure. The earlier causeways and damaged bailey bridges embodied a series of interconnected vulnerabilities, including inadequate flood carrying capacity, inevitable seasonal failures, poor economic inefficiency, and unacceptable social costs. As a result, disruption of connectivity during the monsoon season had become a predictable and recurring condition rather than an exceptional occurrence.

The newly constructed steel truss girder bridges directly address these vulnerabilities through comprehensive engineering solutions. The structures are designed to safely accommodate the 2014 design flood discharge levels, provides adequate deep scour protection, incorporates multi-hazard resilience (flood and seismic), and with an intended service life with minimal maintenance.

By adopting disaster-resilient infrastructure standards and international best practices promoted by the World Bank, the project not only facilitates recovery from the devastating impacts of the 2014 floods but also strengthens the region's capacity to withstand future natural disasters. Collectively, these interventions secure uninterrupted connectivity, enhance socio-economic resilience, and deliver enduring benefits to communities across the concerned districts for generations to come.

The World Bank-funded JTFRP bridges bring modern engineering standards and quality assurance to the valley's infrastructure, setting benchmarks for future projects and capacity building among local contractors and agencies. Overall, these bridges under JTFRP are transformative projects that not only restore and upgrade vital infrastructure but also lay the foundation for long-term resilience, prosperity, and sustainable development in Kashmir Division.

END OF REPORT

ANNEXURE

COMPLETION CERTIFICATES

4.6 ANNEXURE: COMPLETION CERTIFICATES

WORK COMPLETION CERTIFICATE

To Whom It May Concern

Name of the Work	Design and Construction (Complete Job) of 2-Lane bridge at Wayil, Ganderbal including construction of Approach roads and Nallah training works (1x110m single span semi arch segmental through type trussed steel girder bridge)
Name of the Contractor	M/S MM Shawl Engineers and Contractors Pvt. Ltd.
LOA No & Date	23-04-2019
NTP No. & Date	
Type of Contract	Bridge
Contract Period	
Date of Commencement of Work	27-06-2019
Date of Completion as per Contract Agreement	20-01-2021
Extended Date of Completion of Work	26-05-2023
Actual Date of Completion	26-05-2023
Defect Liability Period	
Allotted Cost	26.84 Crores
Expenditure Till Date	27.84 crores including Reimbursement of Addl. GST 6% against total release of Rs. 28.76 Crores
Remarks	

Executive Engineer
(R&B) Division Ganderbal

WORK COMPLETION CERTIFICATE

To Whom It May Concern

Name of the Work	Construction of 02 lane 3x30mtr span truss girder Bridge at Ashajipora Kamad Sadoora road Km 4th including construction of approach roads and Nallah training works.
Name of the Contractor	Khanday Infra Structure Pvt. Ltd. Nipora
LOA No & Date	CE/RBK/WS-9647-51 dated 04-07-2019
LOI/NTP/Allotment No. & Date	CE/RBK/WS-9647-51 dated 04-07-2019
Type of Contract	Turnkey Job
Contract Period	18 Months
Date of Commencement of Work	09-11-2020
Date of Completion as per Contract Agreement	03-01-2021
Actual Date of Completion	15-06-2023
Defect Liability Period	01 year
Allotted/Awarded Cost	Rs.631.00 lacs.
Revised Cost(variation if any)	Rs. 644.75 Lacs
Completion Cost	Rs. 644.75 Lacs
Expenditure Till Date	Rs. 600.25 lacs
Handover/Takeover Status	Bridge completed and opened for traffic
Remarks if any	Extension of time granted by Chief Engineer PW(R&B) Department Kashmir upto 03-06-2023 vide his NO. CE/RBK/WS/3203-07 dated 15-05-2023

Executive Engineer
PWD(R&B) Division Qazigund.

WORK COMPLETION CERTIFICATE

To Whom It May Concern

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Name of the Work	Construction of 1X45 Mtr span trussed bridge over nallah Rambiara at Watchi (Kumar Mohalla) including construction of approach road and nallah training works (EPC Mode)
Name of the Contractor	Khanday Infraststructure PVT Limited prof.M/S Ghulam Mohammad Khanday R/o Nipora Anantanag
LOA No & Date	No:-SE/PS/
LOI/NTP/Allotment No. & Date	No:- SE/PS/22-26 Date:- 2-4-2019.
Type of Contract	Construction of Bridge
Contract Period	N/A
Date of Commencement of Work	N/A
Date of Completion as per Contract Agreement	N/A
Actual Date of Completion	N/A
Defect Liability Period	N/A
Allotted/Awarded Cost	Rs:- 311.00 Lacs.
Revised Cost(variation if any)	Rs: 311.00 lacs
Completion Cost	311.00 Lacs
Expenditure Till Date	301.10 lacs
Handover/Takeover Status	Bridge opened for trafic
Remarks if any	100% Completed

Executive Engineer
PWD(R&B) Division Zainapora

WORK COMPLETION CERTIFICATE

To Whom It May Concern

Name of the Work	Construction of two lane 400 Mtr bridge Chambgund Kulgam road
Name of the Contractor	M/S TARMAK
LOA No & Date	CE/RBK/WS/4359-65 Dtd: 11-05-2019
LOI/NTP/Allotment No. & Date	9652-58 Dtd: 04-07-2019
Type of Contract	Civil
Contract Period	36 Months
Date of Commencement of Work	28-11-2020
Date of Completion as per Contract Agreement	30-06-2023
Actual Date of Completion	30-06-2023
Defect Liability Period	36 Months
Allotted/Awarded Cost	3240.055
Revised Cost (variation if any)	Nil
Completion Cost	3240.055
Expenditure Till Date	3240.055
Handover/Takeover Status	Commissioned
Remarks if any	Project stands completed both physically & financially, however GST @ 6% amounting to Rs. 72.00 lacs is yet to be disbursed.

Executive Engineer
(R&B) Division Kulgam

WORK COMPLETION CERTIFICATE

To Whom It May Concern

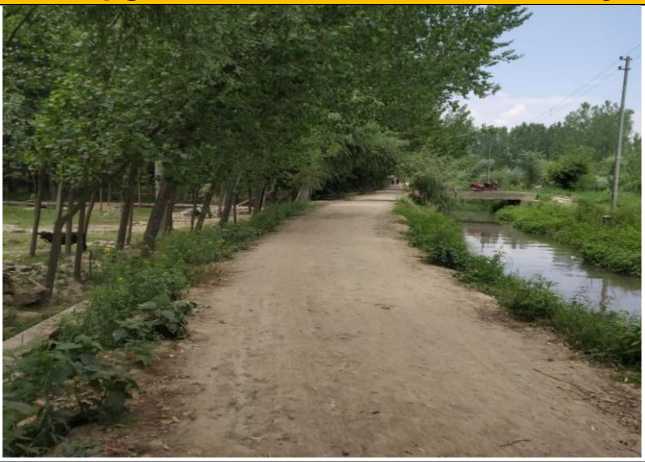
Name of the Work	DESIGN AND CONSTRUCTI (complete Job) of Single lane Bridg Kalaiban Baramulla incluc Construction of Approach roads Nallah training works
Name of the Contractor	M/S Altaf Construction
LOA No & Date	No: 4461-65 dated: 01.07.2019
LOI/NTP No. & Date	No: 5401-05 dated: 17.07.2019
Type of Contract	Turn Key
Contract Period	12months
Date of Commencement of Work	01.09.202[illegible]
Date of Completion as per Contract Agreement	01.07.2022
Actual Date of Completion	01.07.2022
Defect Liability Period	12months
Allotted/Awarded Cost	263.90
Revised Cost	263.90
Completion Cost	263.90
Expenditure Till Date	263.90
Remarks if any	Completed & Opened for Traffic

Executive Engineer,
R&B Division Baramulla

ANNEXURE II: Before & After Photographs of Bridge sub-projects under JTFRP

Pre-construction view: Temporary wooden footbridge at the Wachi Bridge site, Shopian.

Post-upgradation view of the Wachi Bridge at Shopian



BEFORE: Approach Road leading to Waachi Bridge

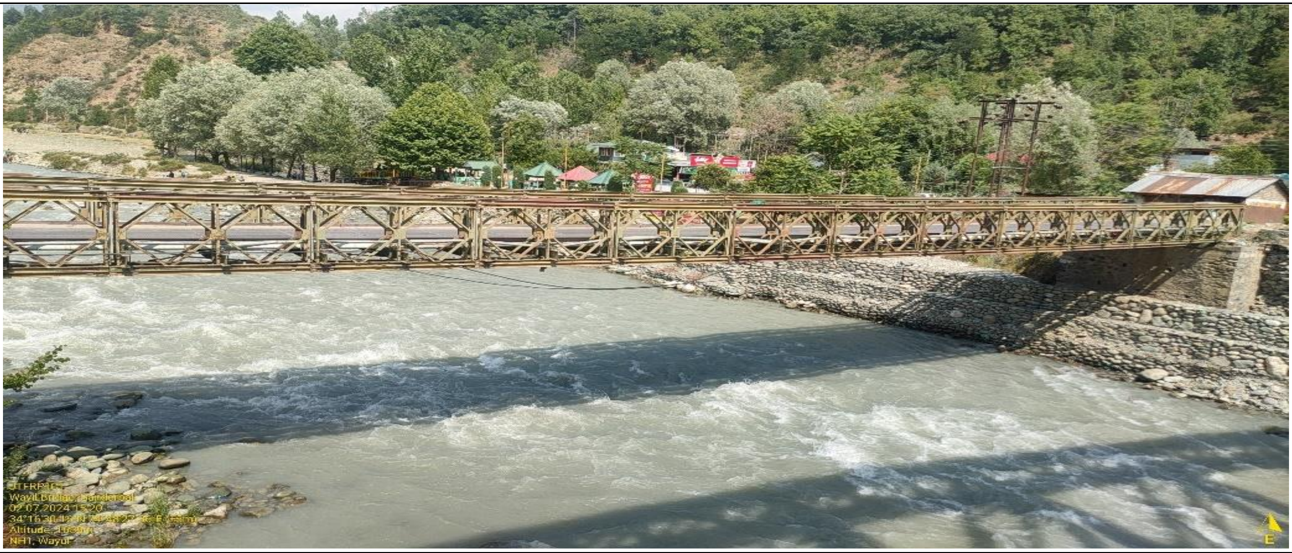
AFTER: Approach road to Wachi Bridge following upgradation.

Pre-construction view: Temporary Bailey bridge at the Sadoora Bridge site, Anantnag.

Post-upgradation view of the Sadoora Bridge at Anantnag.

BEFORE: Approach Road leading to Sadoora Bridge

AFTER: Approach Road to Sadoora Bridge following upgradation.



Pre-construction view: Temporary Bailey bridge at the Wayil Bridge site, Ganderbal.

Post-upgradation view of the Wayil Bridge at Ganderbal.

BEFORE: Approach Road leading to Wayil Bridge

AFTER: Approach Road to Wayil Bridge following upgradation

Pre-construction view: Temporary Bailey bridge at the Trenz Bridge site, Shopian.

Post-upgradation view of the Trenz Bridge at Shopian.

Pre-construction view: Temporary Bailey bridge at the Rohmoo Bridge site, Pulwama.

Post-upgradation view of the Rohmoo Bridge at Pulwama.

Pre-construction view of the Chambgund Bridge site, kulgam.

Post-upgradation view of the Chambgund Bridge at Kulgam.

Pre-construction view of the Kaliban Bridge site, Baramulla, depicting a temporary wooden footbridge constructed by local residents following the 2014 floods to facilitate stream crossing.

Post-upgradation view of the Kaliban Bridge at Baramulla.