Pre-stressed Carbon Fiber Plate "Locks" Concrete Cracks of Bridge

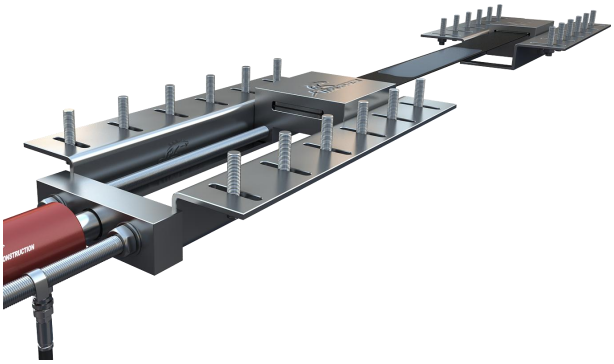
1. Project Background

On busy highway bridges, the structure has long been subjected to traffic loads brought by urban development. After years of heavy-load tests, obvious vertical cracks have appeared on the bridge web. If not handled in a timely manner, the cracks are likely to penetrate the entire web section and even extend to the upper and lower flanges, seriously affecting structural durability and bearing safety. To ensure the long-term service life of the bridge and driving safety, it is necessary to adopt reliable reinforcement technology for targeted treatment.

2. Analysis of Crack Causes

- Design Aspect: The early beam design focused on economy, resulting in a thin web and insufficient stirrup reinforcement, leading to low shear capacity reserve. Under dynamic loads, shear cracks are likely to occur, reducing the overall stiffness and bearing capacity.
- Construction Factors: These include support voids, web thickness insufficiency caused by formwork positioning deviations, and uneven concrete pouring quality, all of which weaken the shear performance of the web.
- Environmental Impact: The shrinkage and creep effects of concrete have further aggravated the development of cracks.

3. Reinforcement Technology Comparison: Traditional Methods vs. Prestressed Carbon Fiber Plate Technology



What is the HM Pre-stress carbon fiber reinforced polymer(FRP) laminate system?

- HM pre-stressed FRP laminate system is composed of carbon fiber laminates, and anchoring device.
- through the clips make the stress to carbon fiber laminates, make the laminates anchoring to concrete permanently, and that will add the stress to the concrete in bending direction.
- the increasing stress can remove or retard the stress hysteresis of the added structures, make the

existing crack reducing or even closed completely, so that to achieve real reinforcing.

Comparison Dimension	Traditional Reinforcement Methods (Steel Bonding, Section Enlargement)	Prestressed Carbon Fiber Plate Reinforcement Technology
Reinforcement Efficiency	Limited effect, passive force bearing	Active prestress application to offset the tensile stress of the T-beam in advance; reinforcement efficiency is more than 30% higher than that of ordinary carbon fiber plates
Structural Deformation	Cannot effectively inhibit beam deflection	Can significantly inhibit T-beam deflection deformation, delay or even close existing cracks (better reinforcement effect on cracked T-beams)
Additional Load	Increases structural self-weight and affects bridge clearance	The weight of the carbon fiber plate is only 1/4 of that of steel; no heavy equipment is needed for construction, and no additional load is added to the T-beam
Durability	Prone to corrosion and aging, general stability	Carbon fiber plates are corrosion-resistant and anti-aging; the supporting prestressed anchoring system has strong stability, suitable for long-term outdoor service scenarios of bridges
Construction Difficulty	Complex process, long construction period, great impact on traffic	Tensioning and bonding are completed in one step; simple construction, short construction period, and little interference to traffic

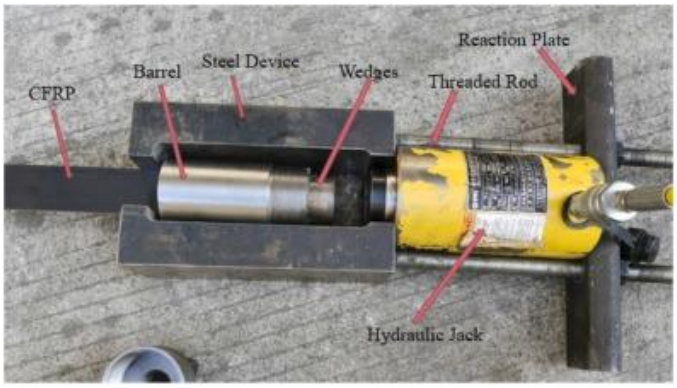
Pre-stress FRP strengthening system (patent number:ZL.2014.2.0115709.1)			
Prestress carbon fiber plate	HM-1.2T	Thickness	1.2mm
		Width	50mm/100mm
		Length	100m/roll
	HM-1.4T	Thickness	1.4mm
		Width	50mm/100mm
		Length	100m/roll
	HM-2.0T	Thickness	2.0mm
		Width	50mm/100mm
		Length	100m/roll
	HM-3.0T	Thickness	3.0mm
		Width	50mm/100mm
		Length	100m/roll
Self lock anchorage	HM-MJ100		
	HM-MJ50		
	HM-MJ20		
	HM-MJ-G50		

Pre-stress Carbon Fiber Laminate Performance Parameters	
Tensile Strength (MPa)	≥2800
Tensile Modulus （MPa)	≥1.6×105
Elongation （%)	≥1.6
Interlaminar Shear Strength （MPa)	≥50
Cohesive pulling strength with concrete (MPa)	≥2.5 (Concrete cohesion damage)

4. Specific Reinforcement Scheme

- Crack Repair: First, treat the crack surface with sealant, then inject HM-120L crack repair agent to conduct in-depth repair of cracks penetrating into the concrete interior.

- Carbon Fiber Plate Bonding: Vertically bond 2mm thick and 100mm wide prestressed carbon fiber plates along the bottom plate, and strengthen the mid-span area to form a composite bearing system.



- Anchoring System: Adopt a supporting special anchoring system to ensure the firm combination of the carbon fiber plate and the beam, and guarantee the long-term stability and durability of the reinforced structure.