UNIVERSITY OF TRANSPORTATION AND COMMUNICATIONS
SECTION OF URBAN TRANSPORT WORKS

THE BONDING STEEL PLATES AND CARBON FIBER REINFORCED POLYMER PLATES TECHNOLOGY FOR REPAIRING CONCRETE BRIDGES IN VIET NAM

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PART 1:
EXISTING CONCRETE BRIDGES REPAIRED BY BONDING STEEL PLATES AND CARBON FIBER REINFORCED POLYMER PLATES IN VIET NAM AFTER 14 YEARS OF SERVICE

- Nowaday, there are a lot of highway bridges, railway bridges in Viet Nam that been built from many years, some structures occur cracks in beam, slab and head beam. These problems limit serviceability and reduce durability of structures.

- We have been strengthened by bonding steel plates and carbon fiber reinforced polymer plates in some bridges such as: Ba - Ren bridge, Tran – Thi - Ly bridge, railway bridges on Km 410+580, Km411+800, KM983+900 and Km 995+693. The detail technology is presented in part 2 of this report.

- The service load and durability of these bridges were promoted remarkably. In August 2005, UCT and Vietnam Road Adminitration staff inspected them and confirmed the effectivity of bonding repair technology.

CHAPTER I:
EXISTING OF TRAN-THI-LY BRIDGE THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES AND CARBON FIBER REINFORCED POLYMER PLATE

1. General

- Tran - Thi - Ly bridge crosses the Han river on Highway No 14B in Da Nang city.
- Bridge parameters:

  + Bridge width: 7m

  + Load design: H13, X60 live load and pedestrian load of 300kg/m2.
- The foundation of bridge was strengthened by 4 bored piles with D=0,6 or 0,8m. The head beam of pier using concrete #300, have 17,4m length and 2,1 m hight.
- Span structure is prestressed beam of 30,84m length. There are 3 beam in bridge cross section spacing in 2,4 m.
- Tran – Thi - Ly bridge have been strengthened from 1999. After that, there were some cracks with length from 7 to 13 cm.

2. Existing of Tran-Thi-Ly bridge that have been strengthened by bonding steel plates and carbon fiber reinforced polymer plates

Existing live load of bridge are car, bicycle and pedestrian load. After servicing, the bridge appeared some corrupts, example protection layer.

Picture 1: Existing of Tran – Thi Ly Bridge

Picture 2: Surface bridge structure.

Picture 3: Head beam have been repaired by polymer mortar and additional bonding steel plates

Picture 4: Head beam of Tran - Thi - Ly Bridge in 8/2005

Picture 5: Location of protected FRP plates

Picture 6: Some damages of protecting cover of FRP plates

Picture7 : Some damages of protecting cover of FRP plates

3. REPAIRING TECHNOLOGY OF TRAN-THI-LY BRIDGE

THE PURPOSE OF REPAIR:

a)To control the developing of cracks:

- In each side of cross beam, do these:
- Paste on two carbon fiber reinforced polymer plates, dimension 60 x 1.4mm (Sika Carbodur 614) in all of the length (17.4m).
- Paste on two carbon fiber reinforced polymer plates, dimension 60 x 1.4mm (Sika Carbodur 614) in bottom of cross beam (length 5.35m).
- Paste on four carbon fiber reinforced polymer plates, dimension 60 x 1.4mm (Sika Carbodur 614) in two side of the cross beam (length 2.15m).
- Using Sika Mono Top 610 to cover carbon fiber reinforced polymer plates

b) Protecting reinforcing bar and concrete against erosion of environment:

- Filling up Epoxy to cracks, the distant of each hole is 20cm along cracks
- Painting all surface of cross beam by a layer Sika Mono Top 610.

THE STEPS OF CONSTRUCTION:

- Step 1: Remove concrete cover along the cross beam with the dimension 60 x2.5mm
- Step 2: Clean and dry that place
- Step 3: Cover a layer by Sikadur 731
- Step 4: Paste on Sika CarboDur M614.
- Step 5: Paint Sika Monotop 610.
- Step 6: Maintain and perfect.
- Do these works in each side of cross beam. When doing, forbid car over bridge.

CHAPTER II:
EXISTING OF BA - REN BRIDGE THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES.

1. GENERAL:

- Ba - Ren bridge cross a river in Km957+637 on Nation Highway No 1A in Quang Nam province. This bridge was constructed in 1667 - 1970 according to American design.

- The bridge includes 14 span of 18.2m. The total length is 255,59 m. In March 1975 span No 13 was broken. After that it was replaced by composite beam including 5 I steel beam (910x420) and reinforced concrete plate of 20cm thickness

  + Design load: HL93 of AASHO and pedestrian load 300kg/m2.

- There were some cracks with width from 0,8 to 1,5 mm in beam and deck slab of bridge.

- After bonding steel plates, this bridge was servicing under with HL93.

2. Existing of Ba - Ren bridge that have been strengthened by bonding steel plates

Until now, after 12 years servicing, the bridge is good with service load HL93. The crack are not developing. However, there are some rusts in wet places. The reason of this rust is: we did not keep the surface of steel plate clean

Picture 8: Existing of Ba - Ren bridge in Km 957 + 637

***Picture9: S**pan structure of Ba – Ren bridge (**8/2005**)*

Picture 10: The rust in steel inclined plate in wet place

Picture 11: The rust in steel plate in wet place

Picture 12: The rust in steel inclined plate in wet place

3. TECHNOLOGY OF BONDING STEEL PLATE THAT HAVE BEEN DONE FOR THIS BRIDGE

The order of technology of bonding steel plate:

- 1- Preparing formwork, equipment, material
- 2- Removing weak concrete cover with the thickness 3 -:- 7cm. Inspecting cracks and broken area.
- 3 - Checking pH: pH ≥ 10.
- 4- Testing the concrete strength. Requirement strength Rh ≥ 200 kG/cm2
- 5- Decide the thickness of removing layer and the thickness of polymer concrete.
- 6 - Cleaning rust.
- 7 - Cleaning concrete surface that moved .
- 8 - Spreading two Epoxy layer to protect concrete and reinforce.
- 9 - Injecting Epoxy into cracks.
- 10- Use Sika Monotop 610 to spread.
- 11- Painting to protect polymer concrete
- 12- Maintaining concrete.

CHAPTER III:
THE RAILWAY BRIDGE AT KM410+580 THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES.

1. GENERAL:

This is a railway bridge at km 410 + 580 of Huong Hoa – Chiem Hoa – Quang Binh. It is old reinforced concrete bridge. In process servicing, there were many cracks and some brocken areas at the beam, so Railway management had to repair it by bonding steel plates

2. EXISTING OF THIS BRIDGE THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES

- After a long time servicing, this bridge is good with service load of railway. We have some comment such as:
- - The bonding steel plate process is
- - The width of cracks is not developing.
- - The steel plates is good. There is only some rust on the surface of steel plates

Picture 13: Railway bridge in Km 410+580 in August 2005

Picture 14: Some rusts in cangue.

Picture 15: Some rusts in cangue.

CHAPTER IV:
THE RAILWAY BRIDGE AT KM411+800 THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES.

1. GENERAL:

- This is a railway bridge at km 411 + 800 of Huong Hoa – Chiem Hoa – Quang Binh. It is old reinforced concrete bridge. In process servicing, there were many cracks and some brocken areas on the beam, so Railway management had to repair it by bonding steel plates.

2. EXISTING OF THIS BRIDGE THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES

- After a long time servicing, this bridge is good with service load of railway. We have some comment such as:
- - The bonding steel plate process is
- - The width of cracks is not developing.
- - The steel plates is good. The is only some rust on the surface of steel plates

Picture 16: Existing of railway bridge Km 411+800 in August 2005

Picture 17: The cangue

Picture 18: The steel plates

Picture 19: The cangue

Picture 20: The steel plates at the bottom of beam

CHAPTER V:
THE RAILWAY BRIDGE AT KM983+900 THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES.

1. GENERAL:

- This is a railway bridge at Km 983+900 in Phổ Châu - Đức Phổ - Quảng Ngãi. It is reinforced concrete bridge. In process servicing, there were many cracks and some brocken areas on the beam, so Railway management had to repair it by bonding steel plates.

2. EXISTING OF THIS BRIDGE THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES

- After a long time servicing, this bridge is good with service load of railway. We have some comment such as:
- - The bonding steel plate process is
- - The width of cracks is not developing.
- - The steel plates is good. The is only some rust on the surface of steel plates

Picture 21: The railway bridge in Km 983+900 in August 2005

Picture 22: Steel plates

Picture 23: Steel plates at the bottom of beam

Picture 24: There are some rust at steel plate

Picture 25: The rust of steel plate

CHAPTER VI:
THE RAILWAY BRIDGE AT KM995+693 THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES.

1. GENERAL:

- This is a railway bridge at Km 995+693 in Phổ Châu - Đức Phổ - Quảng Ngãi. It is reinforced concrete bridge. In process servicing, there were some cracks and some brocken areas on the beam, so Railway management had to repair it by bonding steel plates.

2. EXISTING OF THIS BRIDGE THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES

- After a long time servicing, this bridge is good with service load of railway. We have some comment such as:
- - The bonding steel plate process is
- - The width of cracks is not developing.
- - The steel plates is good. The is only some rust on the surface of steel plates

Picture 27: Existing of railway bridge Km 995+693 in August 2005

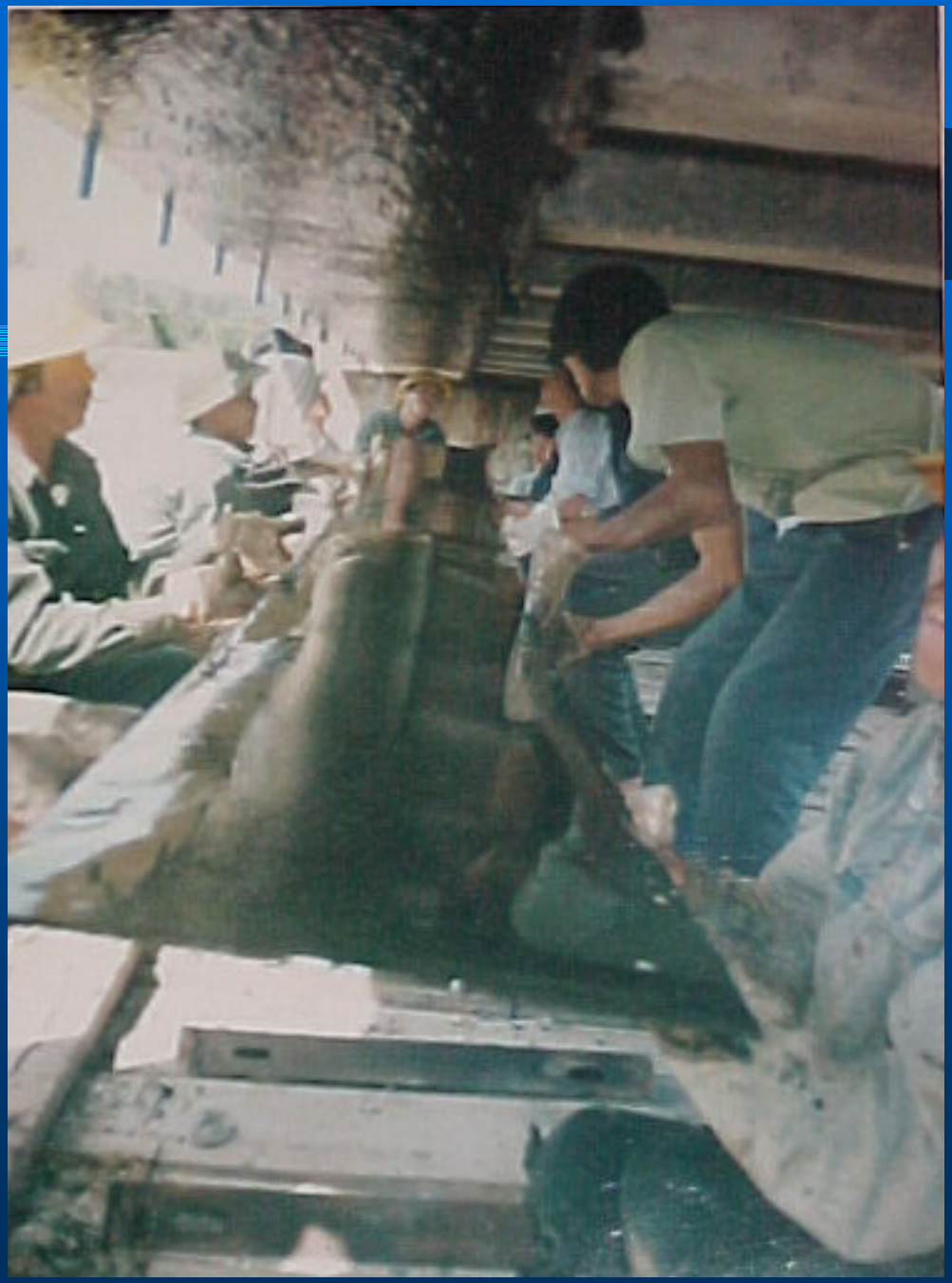
Picture 28: The steel plates after 10 years servicing

Picture 29: The steel plates

Picture 30: Some rusts at steel plate

CHAPTER VII:
SOME BRIDGES IN CUU LONG RIVER LOWLAND THAT HAVE BEEN STRENGTHENED BY BONDING STEEL PLATES.

- There are some bridge in Cuu Long River Lowland that have been strengthened by bonding steel plates. They are good for servicing.
- These are some picture about repairing process and existing of some bridge:

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CHAPTER VIII: CONCLUSION

For a long time servicing, the bridges that have been strengthened by bonding steel plates and carbon fiber reinforced polymer plates are good with service load.

That prove the effect of bonding steel plates and carbon fiber reinforced polymer plates technology.

It is a technology that easy to do, saving time and economy.

It should apply commodious in the old bridges in Viet Nam.