In-Situ VaRTM Repair Method

1. DESCRIPTION

The In-Situ VaRTM (Vacuum assisted Resin Transfer Molding) Repair Method is the CFRP bonding repair and strengthening technique for steel structures which uses vacuum technique to impregnate resin into CF sheets on site.

2. Advantages

① Create high-quality CFRP reinforcement on site.
② Create 3D-reinforcement like stiffener on site.
③ Basically, complete work within 3 days / part.
④ Prevent cure trouble from rain and water.
⑤ Not use the fire or spark (Cold work).

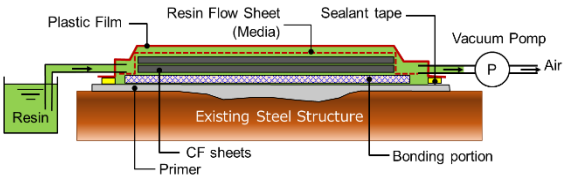


Diagram of the VaRTM Repair Method

3. MATERIALS & MAIN EQUIPMENT

（1）Reinforcement Materials

Material	Product name	Specification
CF sheets	UM46-40P	UD CF sheet with binder, CFAW:400gsm Tensile strength: >2400MPa, Elastic modulus: 440GPa
Bonding layer sheet	G-Flow	Glass fiber mesh sheet, FAW: 500gsm
Impregnating resin	AUP40T1	Epoxy, Normal temperature hardening
Primer	E258R	Epoxy, Normal temperature hardening

（2）Main Equipment and General Secondary Materials

Main Equipment	Vacuum pomp, Digital vacuum gauge Vacuum vessels	Secondary Materials	Peel ply, Resin flow sheet, sealant tape, plastic film, plastic tube

4. INSTALLATION PROCEDURE

1) Surface preparation
Grind substrate, remove corrosion part and expose sound substrate.

2) Primer Application
Apply primer and cure until primer hardening.

3) Reinforcement Materials Placement
Place fiber sheets materials in order to bonding layer sheet, CF sheets.

4) Secondary Materials Placement
Place sealant tape around fiber sheets materials and place peel ply and resin flow sheet on the CF sheets.
Set plastic tubes for air suction and resin injection.
Cover plastic film and seal vacuum zone.

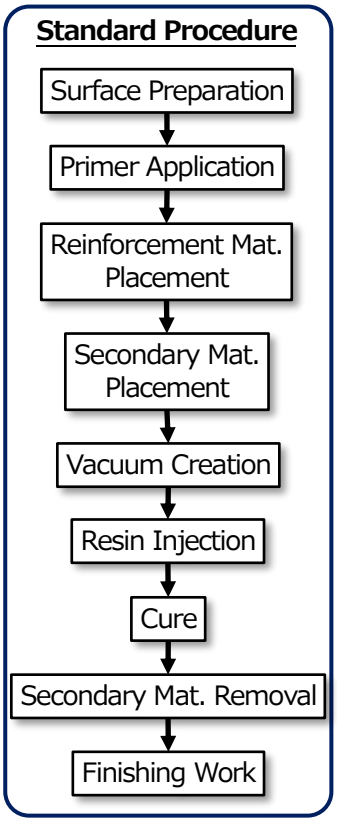
5) Vacuum Creation
Turn on vacuum pomp and create vacuum in the plastic film.
Confirm that vacuum pressure reaches proper value and check that air leak does not occur.

6) Resin Injection
Mix impregnating resin and start to inject it into CF sheets.

7) Cure
Cure until impregnating resin hardening.

8) Secondary Materials Removal
Remove secondary materials.

9) Finishing Work
Coat paint on the repair area.



5. COMPARISON with OTHER REPAIR METHOD

Method	Steel Plate Fastening	CF Sheet Bonding	VaRTM Repair
Photo			
Merit	· Historical technique. · Many technicians. · Many experiences. · Many data.	· Low tool cost · No heavy equipment. · Easy installation.	· High-quality reinforcing. · Create 3D-reinforcement. · Short installation period. · Prevent resin from rain during work.
Demerit	· Degrading member by making holes for fastening bolts. · Re-Corrode again.	· Long installation period · Low-quality reinforcing. · Need countermeasure for water touching until cure.	· Require skilled workers. · Few data.

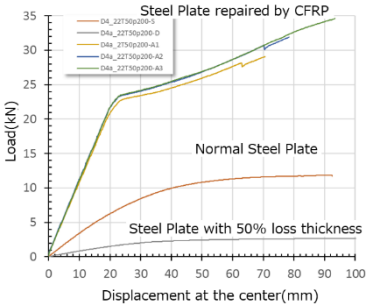
6. PERFORMANCE

（1）CFRP Properties

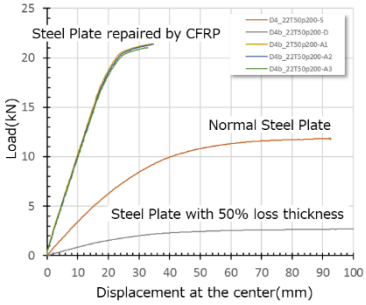
Property	Test standard	Strength (MPa)	Elastic modulus (MPa)
Tension	ISO 527-5	1,330	180,000
Compression	ISO 14126	510	150,000
In-plane shear	ISO 14129	43	3,250

（2）REPAIR EFFECT

· 4 points flexural tests
· Steel PL: 22 ㎜T/11 ㎜T at center, CFRP: 24 plies



Bending Tensile Repair



Bending Compressive Repair

Note: The above data were carried out according to predetermined condition, these data are not guarantee values.

7. APPLICATION

Electric Transmission Tower	Stiffener for Brigde	FPSO's oil tank
		

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