

2) Carbon fiber reinforcement

This repair method is applied for the prevention of concrete falling to protect the third person. It is relative easy to construct, because it takes just bonding carbon fiber sheets using primer, etc.,

It may have applicability to cracking/water leakage/free lime and rebar exposure depending on the damage size.

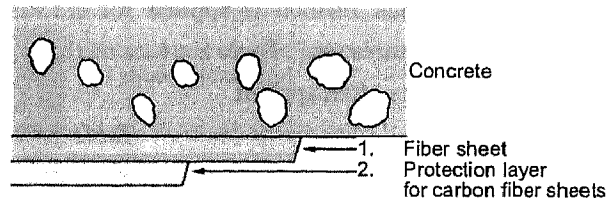


Figure 3.3.6 : Schematic figure of CFR method

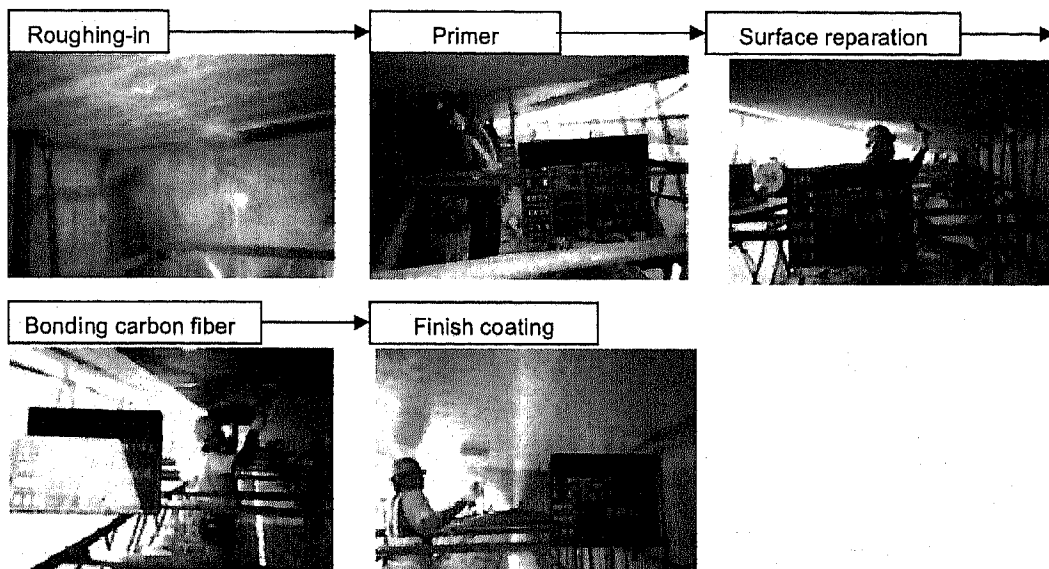


Figure 3.3.7: Work procedure of section repair (Patching)

Table 3.3.7 : Approximate repair cost of CFR

	Unit	Quantity	Unit price(B)	Amount (B)	Remarks
General construction foreman	Man	2.0	5,400	10,800	
Special laborer	Man	5.0	4,700	23,500	
Laborer	Man	2.0	3,600	7,200	
Primer	kg	1.5	1,300	1,950	
Carbon fiber sheet	m ²	20.0	5,300	106,000	2 layers
Overhead	%	50.0	149,450	74,725	
Total(per 10m ²)				224,175	
per 1m ²				22,500	

3) Resin injection

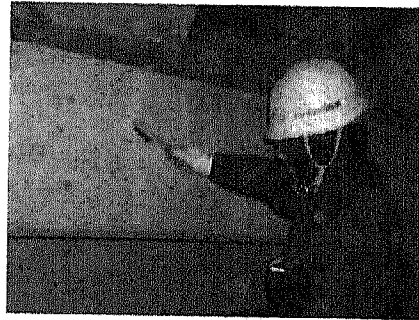
This repair method is applied for cracking/water leakage/free lime of girder, crossbeam, substructures, etc.. There are two methods depending on the crack width. Generally injection method is often applied.

Table 3.3.8 : Resin injection

	Injection method	Filling method
Crack	Relative small crack	Cracks $\geq 0.5\text{mm}$
Outline	Improvement of waterproofing property and durability by injecting resin or cement material	Cutting concrete along the cracking and filling repair material
Schema	<p>Seal material Injection pipe Seal material</p> <p>Crack Crack</p> <p>Hole D=5-10mm</p>	<p>Cut in the crack with U- or V-shape [U-shape] Approx. 10mm [V-shape] Approx. 10mm</p> <p>Crack Crack</p> <p>Filling material</p> <p>Primer Polymer cement mortar Or resin mortar Back-up material</p>

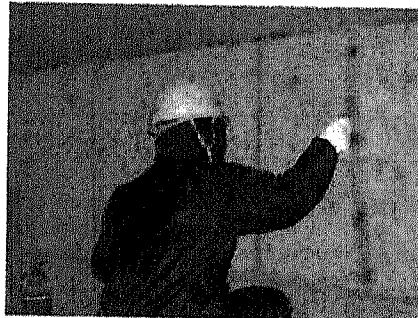
Working procedure

Roughing-in



Removal of grit, dust, oil, contamination on concrete using wire brush etc.

Sealing



Installation of grout hole for injection at regular interval and sealing

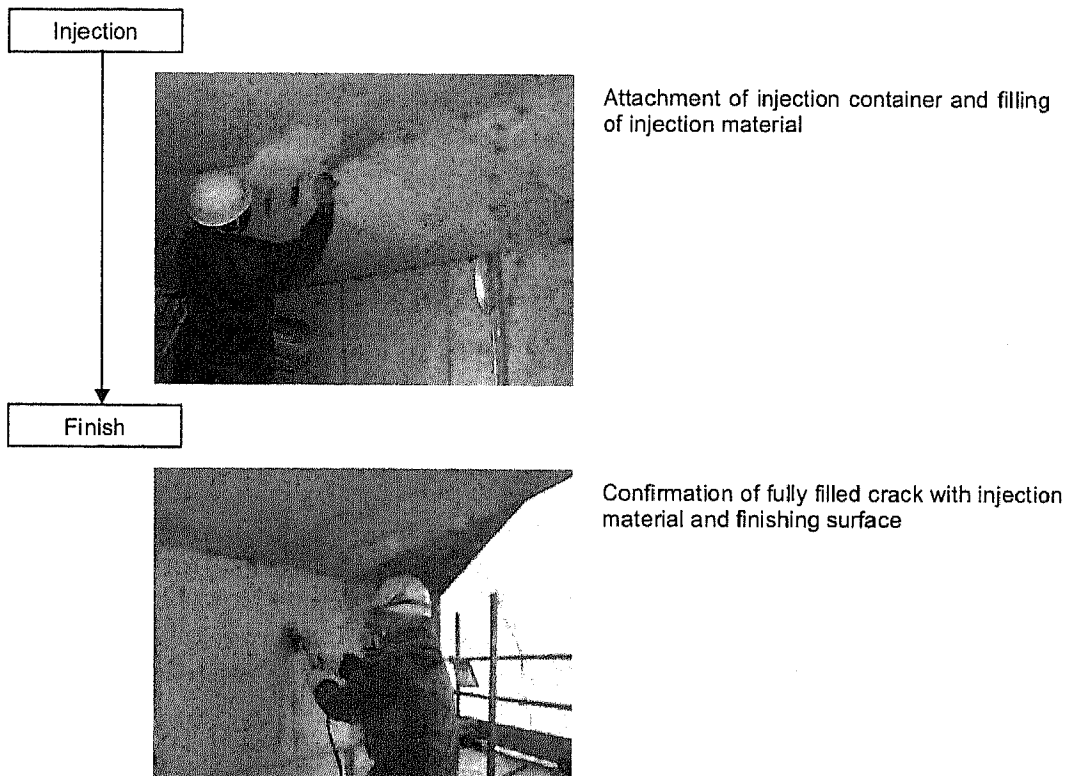


Figure 3.3.8 : Procedure of resin injection method

Table 3.3.9 : Approximate repair cost of injection method

		Unit	Quantity	Unit price(B)	Amount (B)	Remarks
General construction foreman		Man	12.5	5,400	67,500	
Special laborer		Man	25.0	4,700	117,500	
Laborer		Man	12.5	3,600	45,000	
Seal material	(Epoxy resin)	kg	17.6	1,000	17,600	
Injection material	(Epoxy resin)	kg	16.5	1,100	18,150	
Injection apparatus	(Low compressor)	本	334.0	200	66,800	
Overhead		%	50.0	332,550	166,275	
Total (per 100m)					498,825	
per 1m					5,000	

4) Repainting

This is the repair method applied for corrosion of steel members. "Cleaning and washing with water" -> "Surface preparation" -> "Base coat" -> "Second coat" -> "Finish coat" are carried out. Separately scaffolding should be considered in the estimation.

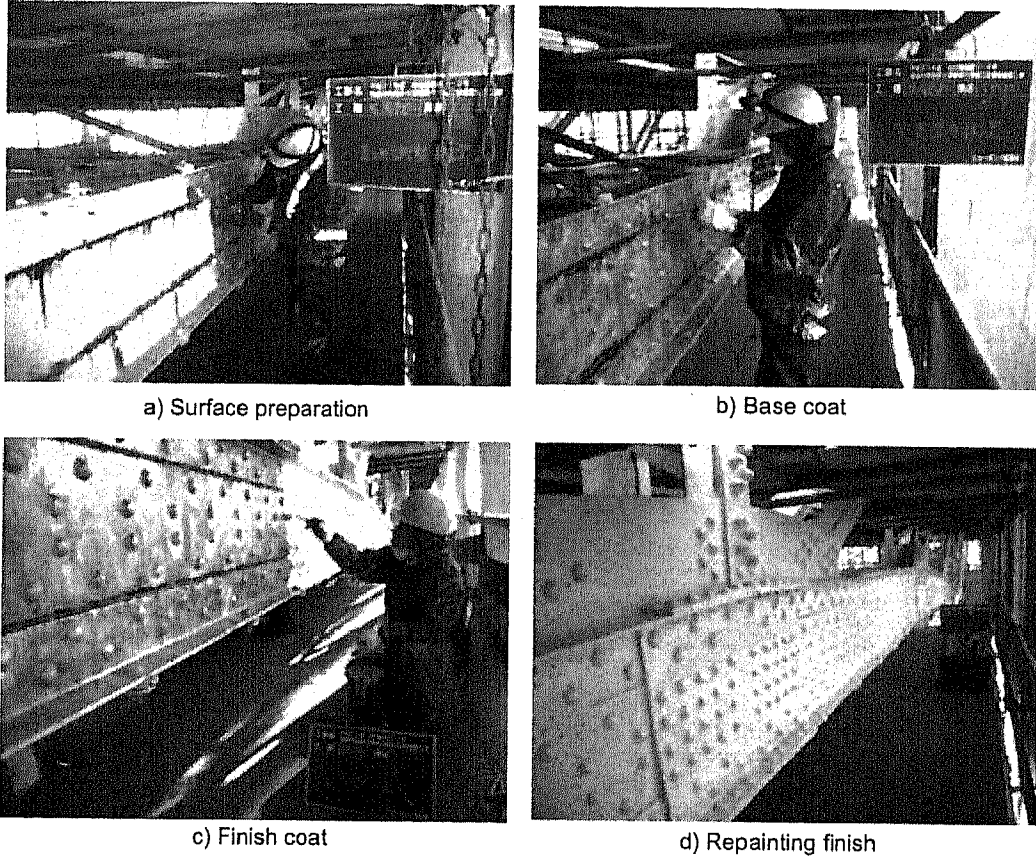


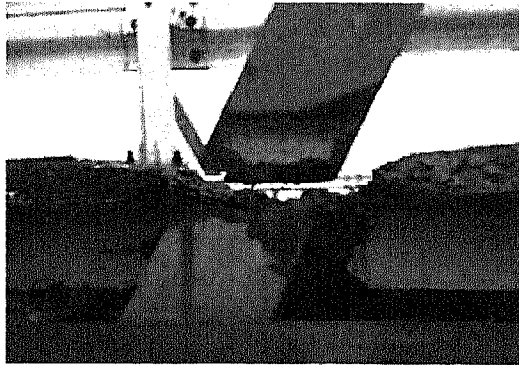
Figure 3.3.9 : Repainting

Table 3.3.10 : Approximate repair cost of repainting

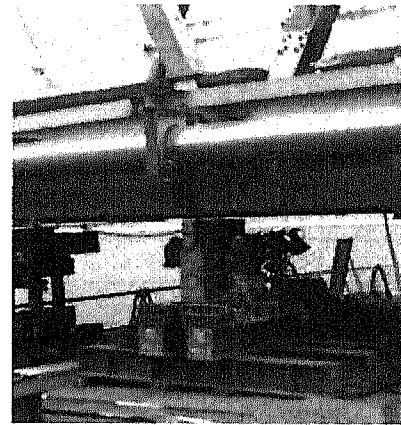
		Unit	Quantity	Unit price(B)	Amount (B)	Remarks
Cleaning and washing with water		m ²	10.0	40	400	
Surface preparation	Cleaning type 1	m ²	10.0	1,270	12,700	
Base coat	Organic zinc rich paint	m ²	10.0	170	1,700	
Base coat	Weak solvent type modified epoxy resin paint (Base coat)	m ²	10.0	190	1,900	
Base coat	Weak solvent type modified epoxy resin paint (Base coat)	m ²	10.0	190	1,900	
Second coat	Weak solvent type fluorine resin paint (Second coat)	m ²	10.0	170	1,700	
Finish coat	Weak solvent type fluorine resin paint (Finish coat)	m ²	10.0	300	3,000	
Overhead		%	50.0	23,300	11,650	
Total (per 10m ²)					34,950	
per 1m ²					3,500	

5) Reinforcement with steel plate

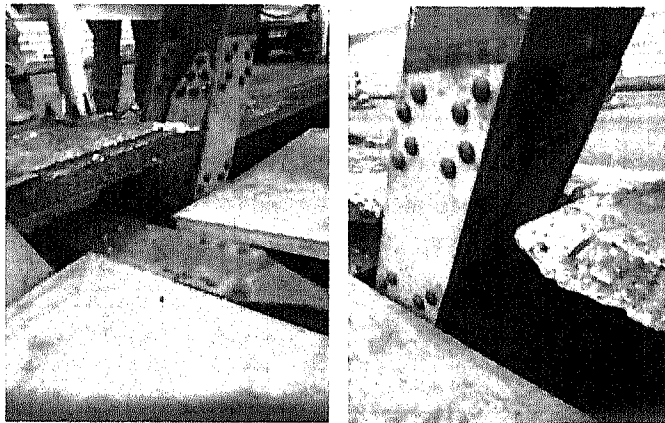
This is the repair method applied for cracking of steel members and also for fracture and deformation / loss.



a) Damage condition



b) Working situation



c) Completed repair work

Figure 3.3.10 : Reinforcement with steel plate

Table 3.3.11 : Approximate repair cost of reinforcement with steel plate

	Unit	Quantity	Unit price(B)	Amount (B)	Remarks
General construction foreman	Man	4.0	5,400	21,600	
Special laborer	Man	8.0	4,700	37,600	
Laborer	Man	8.0	3,600	28,800	
Steel plate	t	0.5	46,200	23,100	
Overhead	%	50.0	111,100	55,550	
Total (per position)				166,650	
Per position				166,700	

6) Bolt replacement of bolts by splice plate

This is the repair method applied for missing bolts in splice plates. Bolts are replaced basically by every splice plate.

Table 3.3.12 : Approximate repair cost of bolt replacement by splice plate

	Unit	Quantity	Unit price(B)	Amount (B)	Remarks
General construction foreman	Man	3.0	5,400	16,200	
Special laborer	Man	6.0	4,700	28,200	
Laborer	Man	6.0	3,600	21,600	
Scaffolding	m ²	4.0	3,000	12,000	
Bolts	t	0.2	54,300	10,860	
Overhead	%	50.0	88,860	44,430	
Total(per position)				133,290	
Per position				133,300	

7) Metal spraying

This is the repair method applied for functional damage of bearing. In the cost estimation for LCC metal spraying is assumed here, while repair method depends on the bearing type.

Table 3.3.13 : Approximate repair cost of metal spraying

	Unit	Quantity	Unit price(B)	Amount (B)	Remarks
General construction foreman	Man	0.5	5,400	2,700	
Special laborer	Man	1.0	4,700	4,700	
Laborer	Man	1.0	3,600	3,600	
Scaffolding	m ²	2.0	3,000	6,000	
Metal spraying	m ²	0.5	126,000	63,000	
Overhead	%	50.0	80,000	40,000	
Total(per position)				120,000	
Per position				120,000	

8) Replacement of pavement

This is the repair method applied for replacement of pavement or road surface including water proofing.

Table 3.3.14 : Approximate repair cost of replacement of pavement

		Unit	Quantity	Unit price(B)	Amount (B)	Remarks
General construction foreman		Man	1.2	5,400	6,480	
Special laborer		Man	3.6	4,700	16,920	
Laborer		Man	6.0	3,600	21,600	
Asphalt mixture		t	25.5	3,900	99,450	
Milling machine operation	Wheel type, Class 2m	Day	1.2	34,200	41,040	
Cleaning car operation	With brush 2-3.1m ³	Day	1.2	14,400	17,280	
Asphalt finisher operation	Wheel type, Class 2.4-6.0m	Day	1.2	36,400	43,680	
Road roller operation	Macadam 10-12t	Day	1.2	11,000	13,200	
Pneumatic tire roller operation	Exhaust emission controlled type 10-12t	Day	1.2	15,000	18,000	
Water proofing layer		m ²	100.0	500	50,000	
Overhead		%	50.0	327,650	163,825	
Total (per 100m ²)					491,475	
per 1m ²					5,000	



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