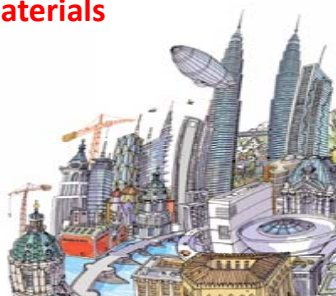


**Repairing and strengthening of bridge structures by using composite materials**




Pierre Hébert  
Manager of Technical Services  
MAPEI inc.

*Two are the main causes of reinforcement corrosion*

```

    graph TD
      A[Carbonatation] --- B[Corrosive contaminants]
      B --- C[At mixing]
      B --- D[From external environment]
      C --- E[Sodium chloride  
Calcium chloride]
      D --- F[Sodium chloride  
Other contaminants]
    
```



*The diagnosis of the deterioration causes is essential before repairing*



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**Carbonation**

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**Chlorides**

Corrosion penetration

Life of the structure

Trigger of corrosion

Cracks in the concrete


Detachment of Concrete

Collapse of the structure

Time

$t_i$

$t_p$



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### Diagnosis of carbonation and chloride penetration

Distance from surface (mm)	Carbonation depth (mm)
0	0
10	10
20	20
30	30
40	40
50	50
60	60
70	70
80	80
90	90
100	100
110	110
120	120
130	130
140	140
150	150
160	160
170	170
180	180
190	190
200	200
210	210
220	220
230	230
240	240
250	250
260	260
270	270
280	280
290	290
300	300
310	310
320	320
330	330
340	340
350	350
360	360
370	370
380	380
390	390
400	400
410	410
420	420
430	430
440	440
450	450
460	460
470	470
480	480
490	490
500	500
510	510
520	520
530	530
540	540
550	550
560	560
570	570
580	580
590	590
600	600
610	610
620	620
630	630
640	640
650	650
660	660
670	670
680	680
690	690
700	700
710	710
720	720
730	730
740	740
750	750
760	760
770	770
780	780
790	790
800	800
810	810
820	820
830	830
840	840
850	850
860	860
870	870
880	880
890	890
900	900
910	910
920	920
930	930
940	940
950	950
960	960
970	970
980	980
990	990
1000	1000

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### Materials for Concrete Repair

- **Corrosion protection of reinforcement**
- **Repair with shrinkage compensated mortars**
- **Strengthening by using composite materials**


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### Materials for Concrete Repair

- **Corrosion protection of reinforcement**
- *Repair with shrinkage compensated mortars*
- *Strengthening by using composite materials*

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### Corrosion-inhibiting systems

**Corrosion-inhibiting cementitious mortar** → 

**Cathodic galvanic protection** →  Example : Movement joints

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### Materials for Concrete Repair

- Corrosion protection of reinforcement
- **Repair with shrinkage compensated mortars**
- Strengthening by using composite materials



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### Substrate preparation



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### Application of structural shrinkage compensated mortars



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### O-Ring Test: Crack Resistance

O-Ring Test



Low shrinkage – after 180 days no cracks must be registered



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## FRP System

- Corrosion protection of reinforcement
- Repair with shrinkage compensated mortars
- **Strengthening by using composite materials**



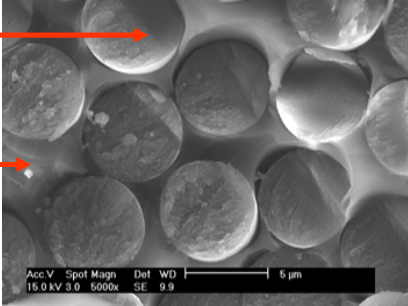
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## Definition

### Fiber Reinforced Polymers

**Fiber**  
Loads carrying  
Optimum properties  
Deformation decreasing

**Matrix**  
Stress transfer  
Protection  
Anchoring  
Toughness  
Fatigue resistance

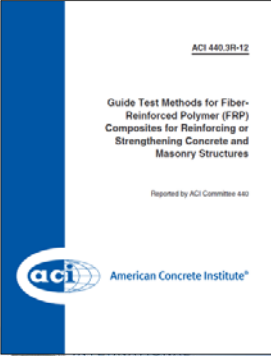




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## Mapei FRP System

### Technical reference documents



### ACI 440

Guide Test Methods for Fiber-Reinforced Polymer (FRP) Composites for Reinforcing or Strengthening Concrete and Masonry Structures



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## Mapei FRP System

### FRP Advantages



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- Hi

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**FRP Quality guarantee**

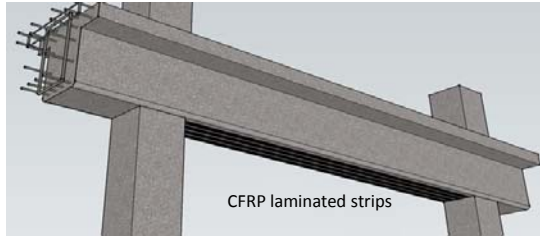



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**FRP System**

Application field

Flexural strengthening



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**FRP System**

Case History: PONTE "Terrassa" Barcellona



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**FRP System**

Experimental campaign

Objective

Experimental program conducted on 5 full-scale PC T-beams with a RC slab designed according to ANAS (Italian Transportation Institute)

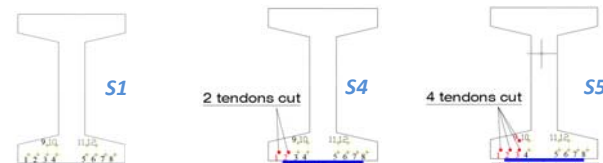


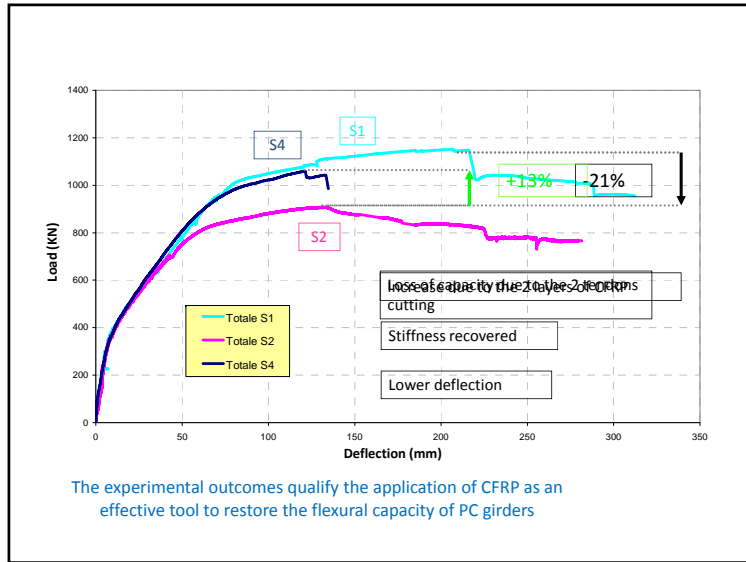
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**FRP System**

Experimental campaign

Sample	Cut tendons	% Damaged	CFRP
S1	0	0 %	-
S2	2	17 %	-
S3	4	33 %	-
S4	2	17 %	2 layers
S5	4	33 %	3 layers





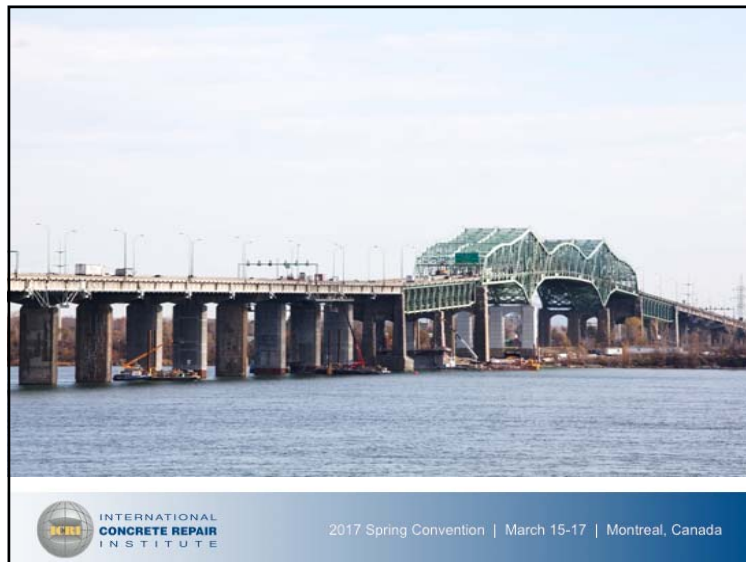
### FRP System

#### Application field

Shear strengthening

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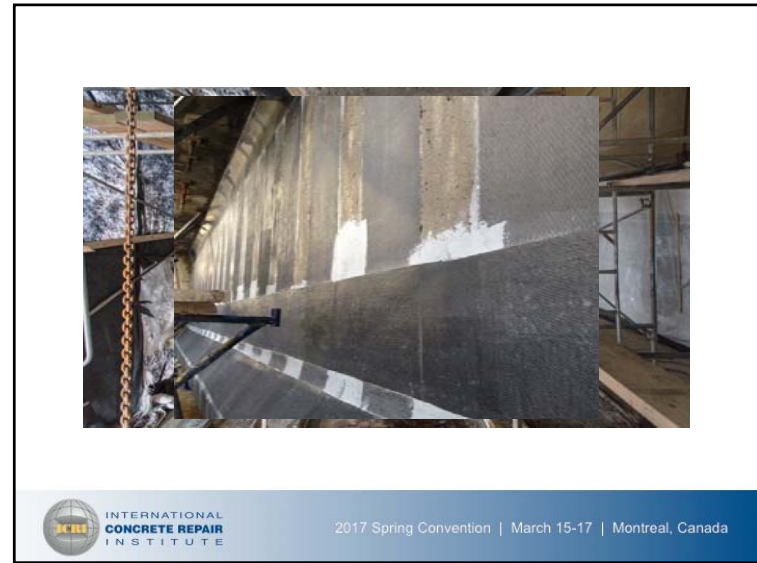
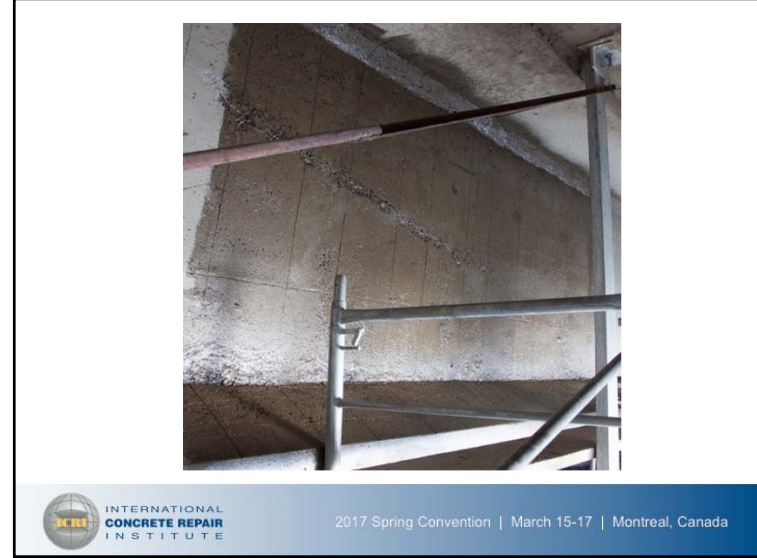
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Buckland & Taylor, Sept 2013

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*Thank you very much for your  
kind attention*

