DURABILITY

TEMPERATURE

Resin: Sudden strength reduction for T > 60-80 °C.

Fiber failure: carbon 650 °C, glass 1000 °C, aramid 200 °C.

MOISTURE

Some strength degradation in resins+fibers in extreme cases (continuous wetting). More succeptible is aramid, carbon is not affected, glass suffers some reduction.

UV

Surface of resin is affected (discolouration, microcracking). Carbon and glass fibers are not affected, aramid's mechanical properties deteriorate.

ALKALINE OR ACID ENVIRONMENT

Glass fibers are attacked – should be protected by resin. Carbon is extremely durable.

STRESS CORROSION

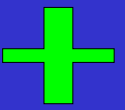
Reduction of tensile strength in glass fibers under stress.

Ranking of fibers based on durability

Criterion	Carbon	Glass	Aramide
High temperature	+	++	-
Moisture	+	-	-
UV	++	+	-
Alkaline and acid environment	++	--	+
Galvanic corrosion	--	+	+
Creep	++	--	-
Creep fracture, stress corrosion	++	--	+
Fatigue	++	-	+
Impact	-	+	++

SUMMARY AND CONCLUSIONS

- Low weight
- Corrosion resistant
- Availability of long elements
- Easy and fast to apply, low disruption of occupancy
- High strength
- No change of cross section dimensions
- Jacketing without increasing stiffness



- High materials cost (not total !)
- Lack of ductility (but plenty of deformability !)
- Need for fire protection
- Lack of education

What is the FRP-technique good for ?

RC structures

- Flexural strengthening of beams and slabs
- Shear strengthening of beams, columns, shear walls, joints
- Increase of axial capacity of columns through confinement
- Increase of column deformation capacity (ductility) through confinement

What is the FRP-technique good for ?

Masonry

- In-plane & out-of-plane loading (flexure, shear)
- Confinement (including reversible wrapping)
- Arches, vaults, domes

What is the FRP-technique good for ?

Timber

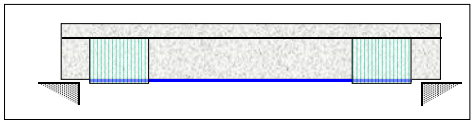
- Flexural strengthening , shear strengthening
- Axial load strengthening
- Stiffening
- Ductility

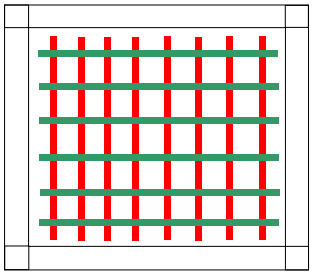
Limitations of the FRP-technique :

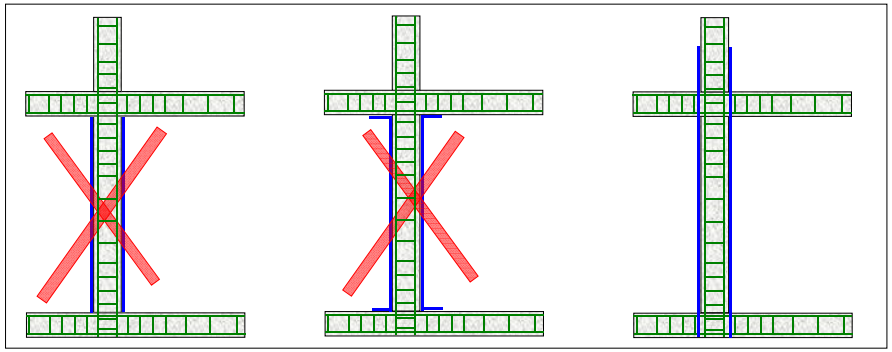
- Flexural strengthening of columns: difficult !
- Increase of stiffness: not possible !

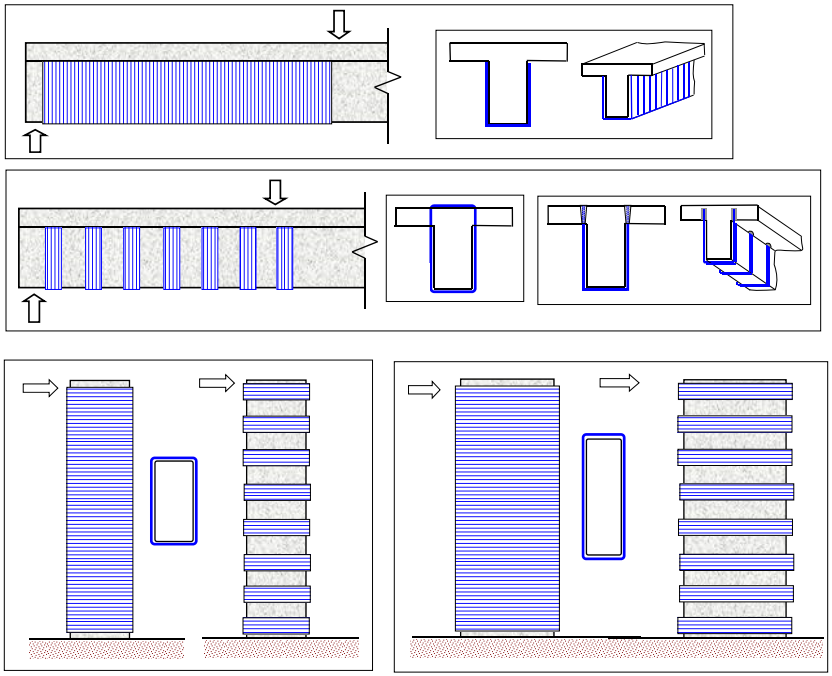
RC jacketing is better in these cases

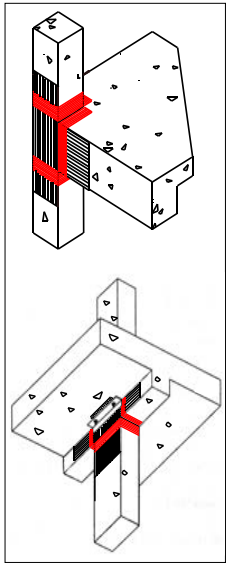
In summary, here is what we can do with FRPs in RC structures :

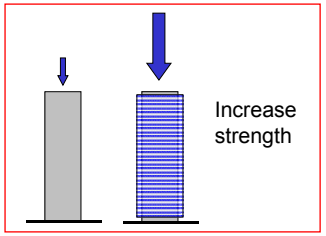


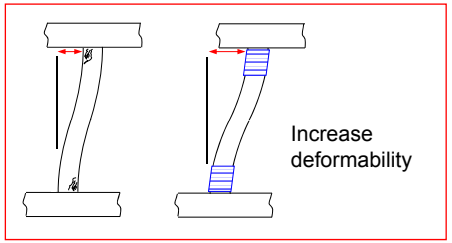


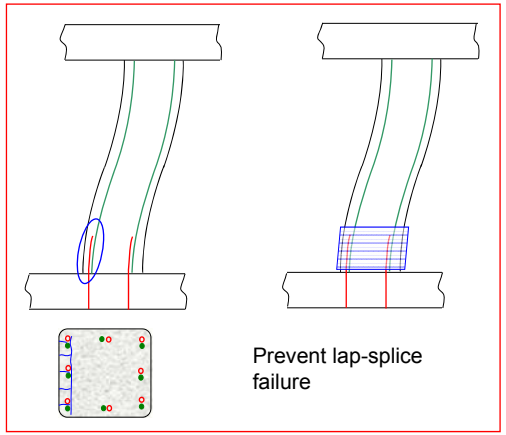


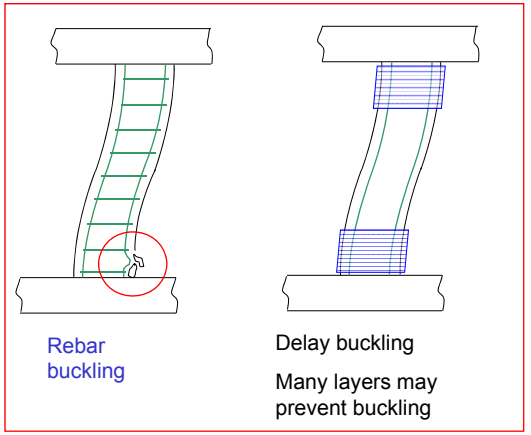












CONCLUSIONS

- EASY, FAST, EFFECTIVE
- BASIC PRINCIPLES
  - FORCES CARRIED BY THE FIBRES
  - LINEAR ELASTIC MATERIAL BEHAVIOUR
  - DEBONDING IS OF CRUCIAL IMPORTANCE
- FLEXURAL STRENGTHENING (BEAMS+SLABS)
- SHEAR STRENGTHENING
- CONFINEMENT
- SPECIAL CARE ON PRACTICAL EXECUTION
- "TRM": AN INTERESTING CONCEPT WHICH WILL PAVE THE WAY FOR EVEN MORE APPLICATIONS OF EXTERNALLY BONDED COMPOSITES !