fib: SAG 7

Assessment and Interventions Upon Existing Structures

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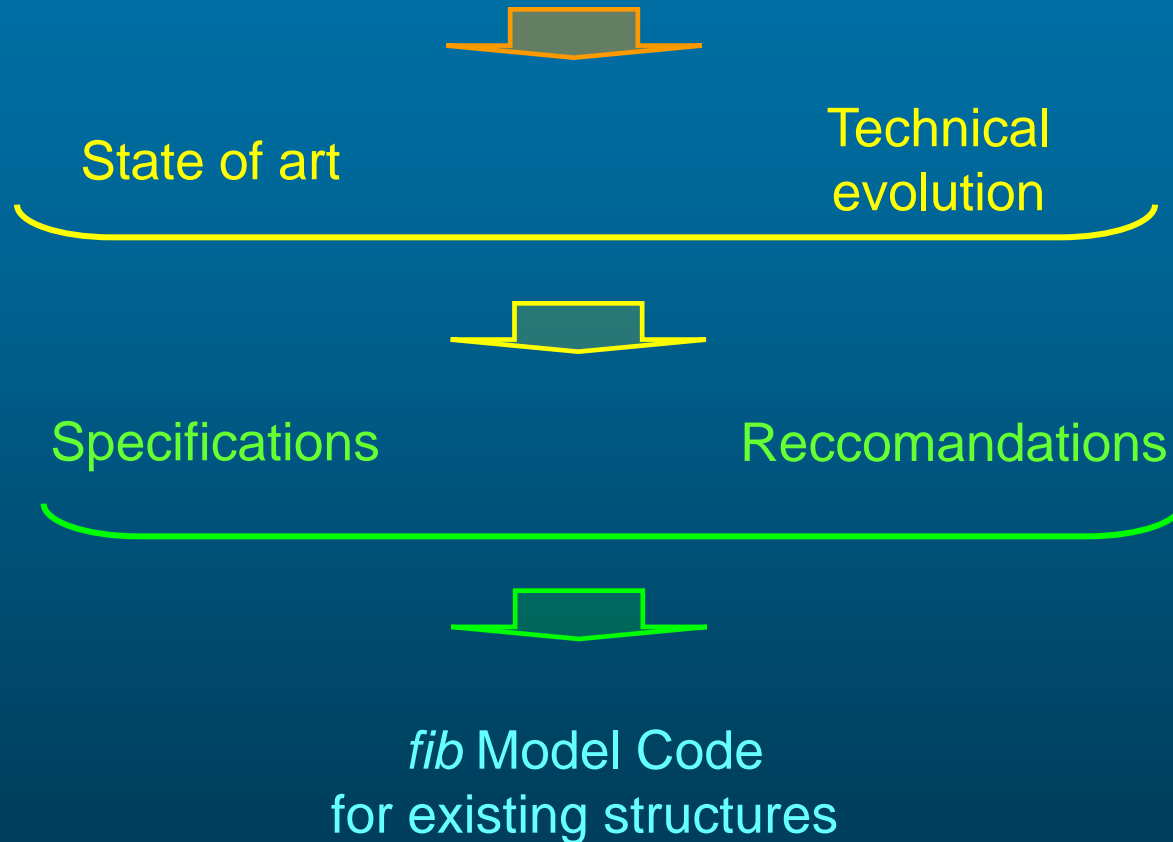Politecnico di Torino - Italy

Scope of work (1)

Define appropriate and reliable procedures to establish the safety of existing structures
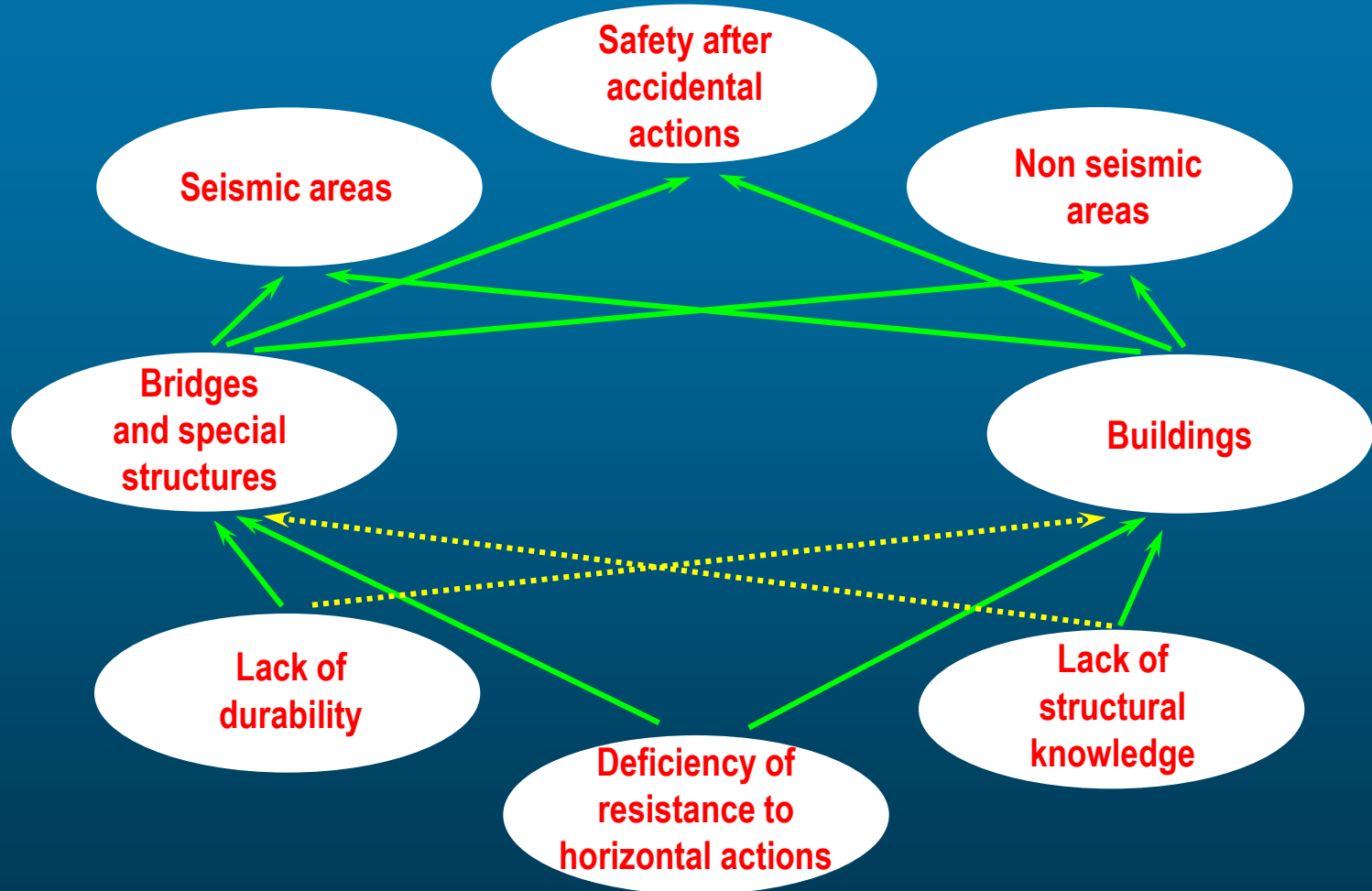
Define the necessary requirements for interventions to extend the safe operation of the working life of existing structures

Scope of work (2)

Documents to be produced including

State of art

Technical evolution

Specifications

Reccomandations

fib Model Code
for existing structures

Reliability and safety evaluation (1)

New probabilistic approach for the definition of the safety format, able to take into account:

- Higher cost to increase safety levels in existing than in new one structures

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- Actual code provisions fulfilment sometime very expensive or impossible

Lower safety level acceptable under certain circumstances

Reliability and safety evaluation (2)

- Residual expected lifetime reduced respect to new structures (50/100 years)

- Consequent reduction of representative values of actions

- Durability requirements reduced or released

Reliability and safety evaluation (3)

- Reduction of uncertainties related to both:

  - Geometrical and materials parameters

  - Structural behavior in presence of a significant set of load cases and related combinations

Reliability and safety evaluation (4)

Recent studies (2010) on this subject
(Vrouwenvelder, Scholten) are proposing:

- A reduction of β values:

$$\beta_{exist} = \beta_{new} - \Delta\beta$$

$$\Delta\beta \cong 1.5$$

Limitations for human safety
criterion (constant annual
failure probability)

Reliability and safety evaluation (5)

Consequences class	Minimum reference period for existing building (years)	β-NEW		β-EXISTING	
		wn	wd	wn	wd
0	1	3,3	2,3	1,8	0,8
1	15	3,3	2,3	1,8*	1,1*
2	15	3,8	2,8	2,5*	2,5*
3	15	4,3	3,3	3,3*	3,3*

Class 0: as class 1, but no human safety involved.

wn = wind not dominant; wd = wind dominant.

*in this case is the minimum limit for human safety normative.

Table 1: Minimum values for the reliability index β with a minimum reference

Reliability and safety evaluation (6)

Consequent reduction of load factors for existing structures

	NEW		EXISTING		
	Permanent unfavourable	Variable	Permanent unfavourable	Wind	Others
STR/GEO (6.10a)					
CC 1	1,20	1,35 Ψo	1,10	1,10 Ψo	1,00 Ψo
CC 2	1,35	1,50 Ψo	1,20	1,30 Ψo	1,15 Ψo
CC 3	1,50	1,65 Ψo	1,30	1,50 Ψo	1,30 Ψo
STR/GEO (6.10b)					
CC 1	1,10	1,35*	1,00	1,10*	1,00*
CC 2	1,20	1,50*	1,10	1,30*	1,15*
CC 3	1,30	1,65*	1,20	1,50*	1,30*

*if not dominant, multiply with Ψo.

Table 2: Load factors for the ultimate limit state

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Structural performance modeling of existing structures (1)

Evaluation of
material parameters

Experimental tests integrated by "a priori knowledge" with
a Bayesian approach

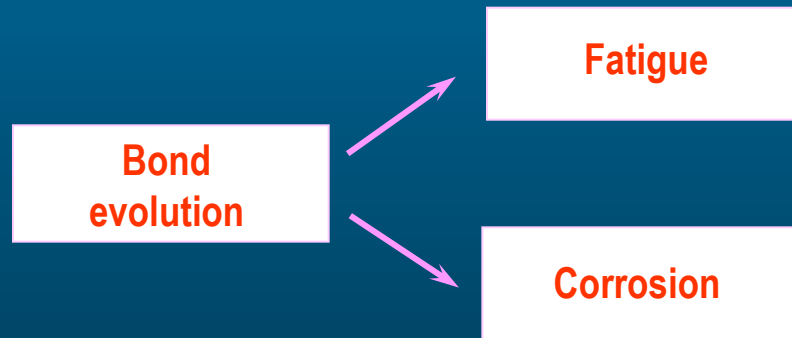# Structural performance modeling of existing structures (2)

- On the overall structure numerical simulations with N.L. analyses and sensitivity analyses on the parameters having a significant influence on the results

- Integration of structural knowledge by means of "a latere" informations derived by load tests on the structure finalized to the numerical model updating
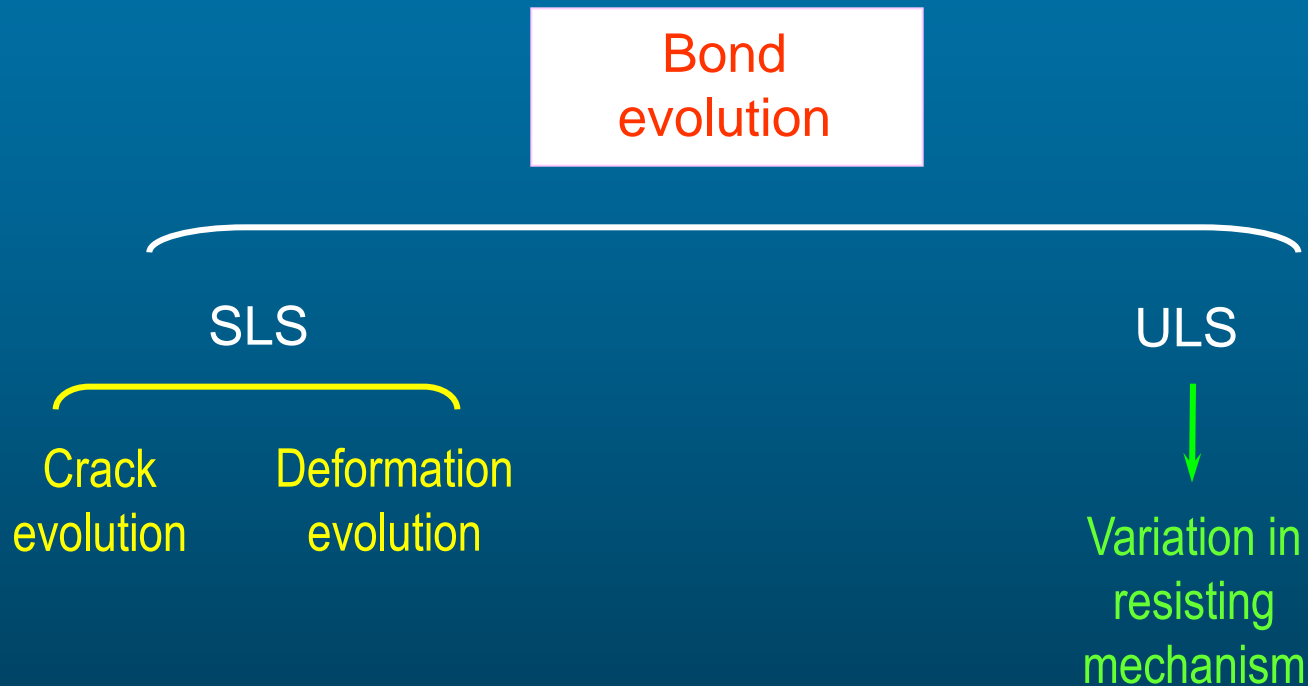
Structural performance modeling of existing structures (3)

- Definition of resisting models in existing structures and their expected evolution in time
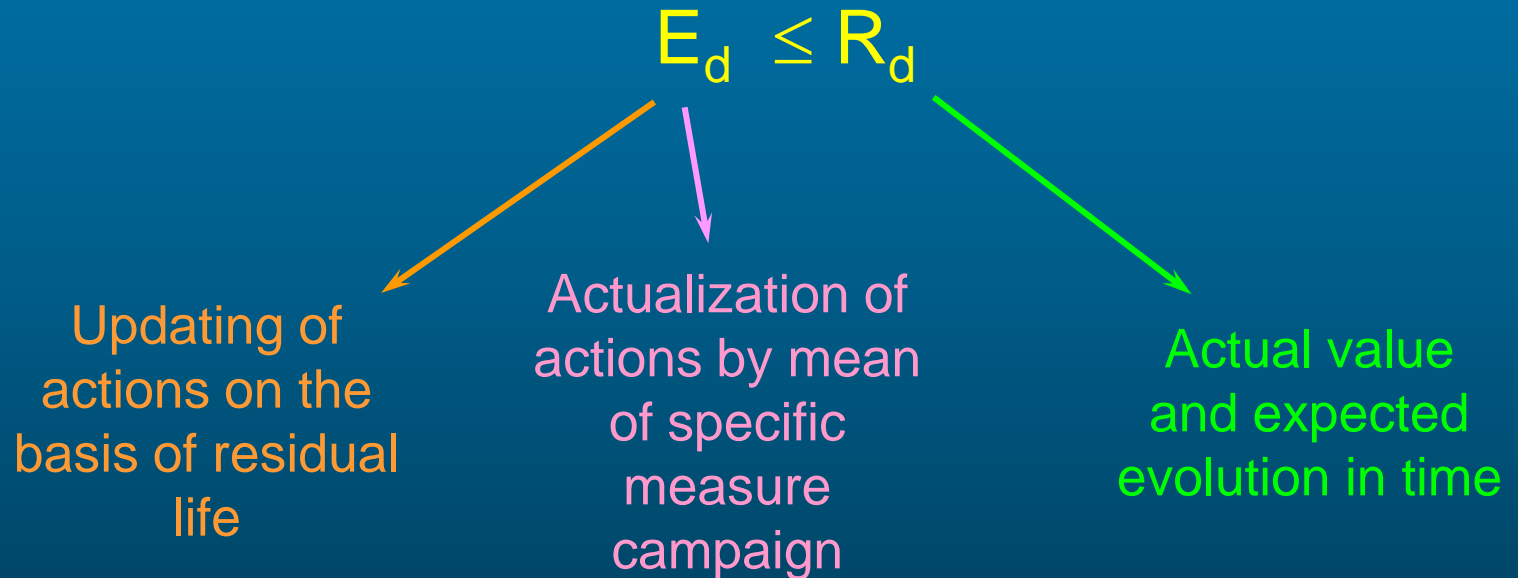
For instance:

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Bond evolution  →  Fatigue
                →  Corrosion
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Structural performance modeling of existing structures (4)

Bond evolution

SLS

ULS

Crack evolution

Deformation evolution

Variation in resisting mechanism

Assessment/evaluation procedure for existing structures (1)

$$E_d \leq R_d$$

Updating of actions on the basis of residual life

Actualization of actions by mean of specific measure campaign

Actual value and expected evolution in time

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CEB•FIP

Assessment/evaluation procedure for existing structures (2)

- Actual safety level

- Estimation of residual life or evolution in time of actual safety level

- Definition of measures necessary to extend the service life

- Strenghtening

- Upgrading

- ………..

Limitations to the operability

Selections and implementation of interventions (1)

Definition of a set of interventions suitable
for the specific scope

Modeling of interventions (interface problems)

Selections and implementation of interventions (2)

- Evaluation of new resisting performance

- Feedback on the overall structure

- New reliability target after intervention

Examples

http://www.acmanet.org/cjrl_10_07_papers/Hamilton.pdf

http://wpage.unina.it/laprota/paper/14WCEE_12-02-0006.pdf

http://www.compositesworld.com/cdn/cms/1008ct-mining3.jpg

Fatigue test

Static test

Thank you for the kind attention