



COST Action
TU I402

Quantifying the Value of Structural Health Monitoring



Optimizing monitoring: application to assessment of roof snow load risks

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INDEX

1. Decision scenario

- 1.1 Framework
- 1.2 Asset description
- 1.3 Monitoring strategy

2. Methods applied

3. Results obtained

4. Value of the SHM information for the owner/concessionaire

5. Open question addressed to decision makers



1. Decision scenario (framework)

- a) Stadium roof **does not** comply with the requirements in EN 1990
- b) snow load (**in winter time**) dominates structural reliability → **continuous monitoring** of snow loads will help
- c) when a specified **limit value** of the monitored parameter is exceeded, either snow on the roof can be removed or the stadium can be temporarily closed.



4000 spectators

1. Decision scenario (asset description)

stadium: constructed in the beginning of 1990s

location: Northern Italy, altitude - 190 m

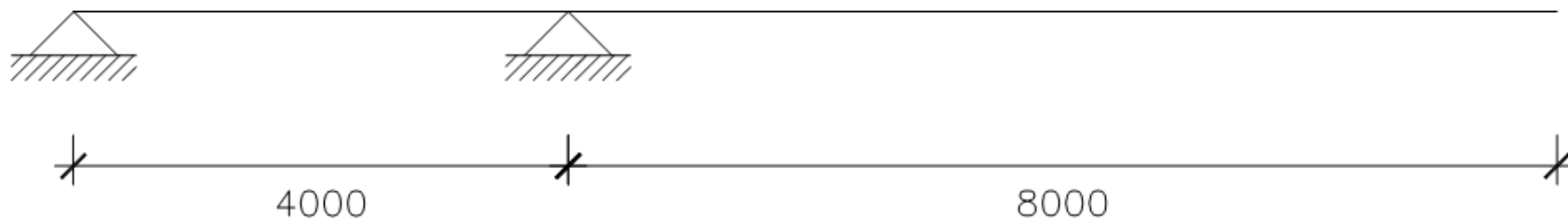
Capacity: 4000 spectators - CC3 structure

key member: cantilever steel beam IPE450

system: spacing between beams - 5 m with stiffening members

design requirements: snow loads: **old code D.M.12.02: 0.9 kN/m²**,
valid code EC1-3: 1.25 kN/m²

design requirements: resistance of the roof is about 90% of that required by the Eurocodes (in terms of design values)



1. Decision scenario (monitoring system alternative)

Alternative	Cost	Uncertainty
M1: meteorological station snow depth on ground	negligible	very high
M2: snow depth on the roof	$C_I = 7000$ Euro $C_O = 800$ Euro /year	high (snow density)
M3: snow load on the roof	$C_I = 14000$ Euro $C_O = 800$ Euro /year	reduced (direct measurement)

2. Methods applied

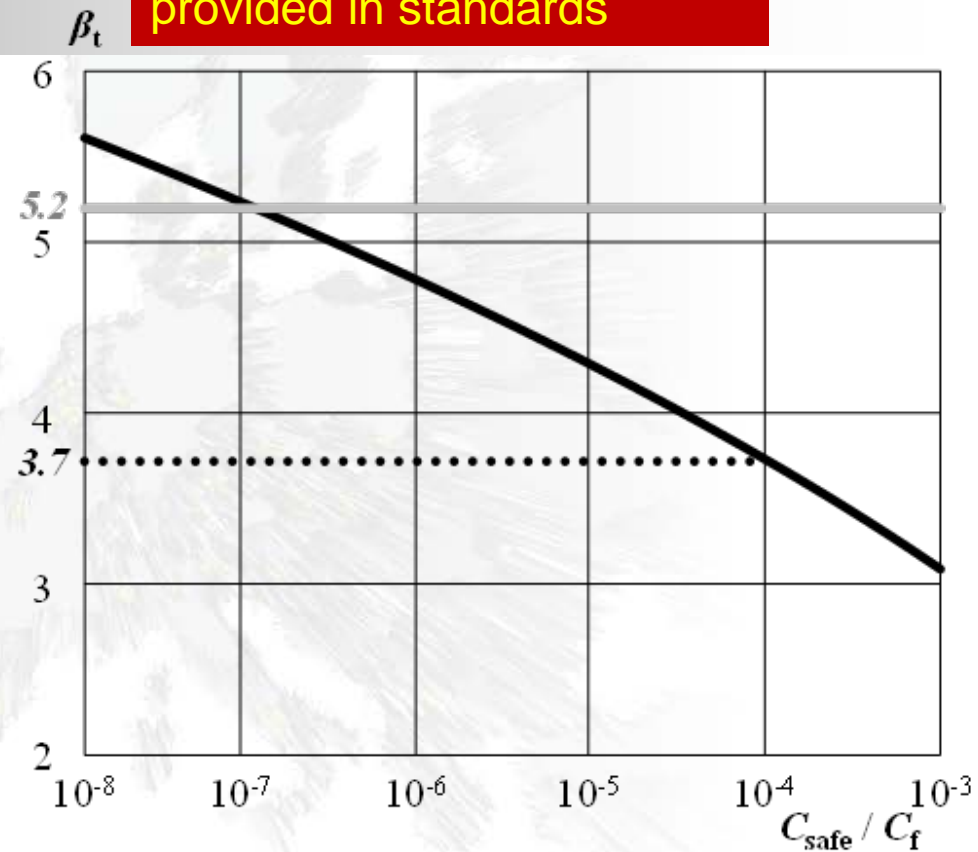
- Uncertainty modelling
- Reliability analysis
- Consequence analysis
- Risk assessment

β_t : target reliability (acceptable safety)
depending on Consequence Class (EN 1990)

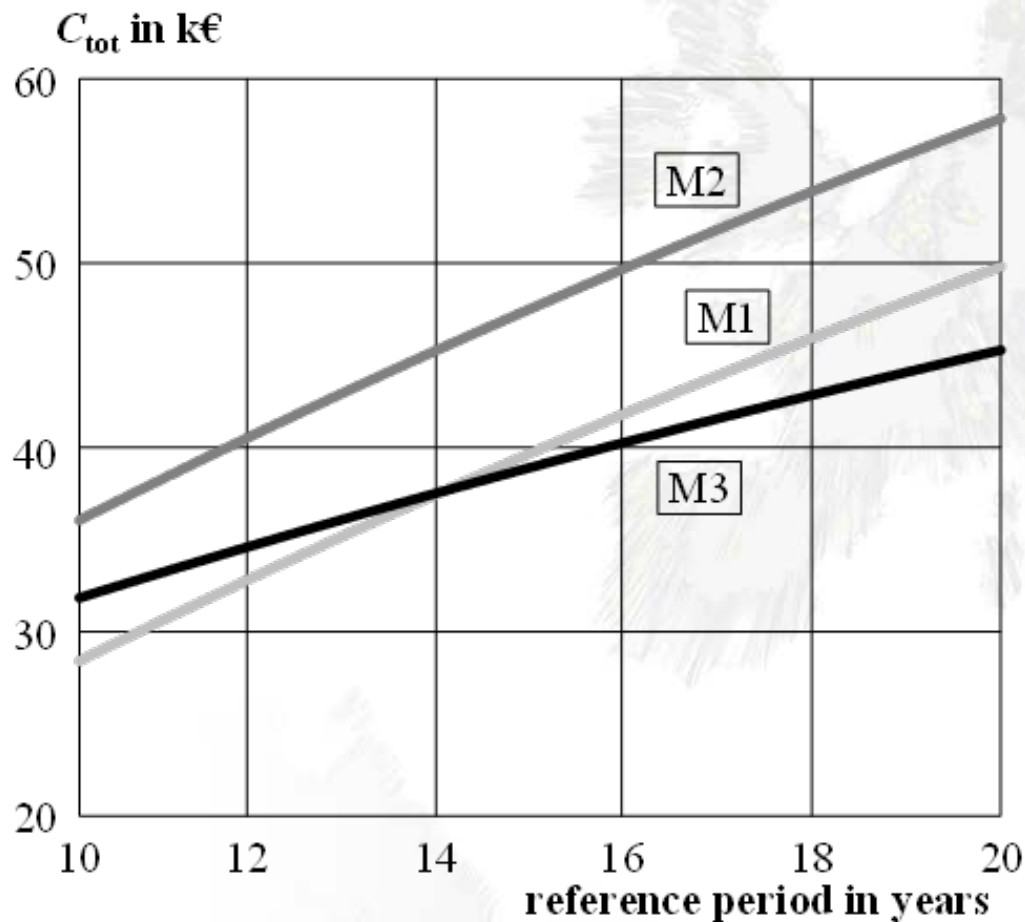
C_{safe} : costs of safety measures cleaning of
roof, temporary closure

C_f : failure costs: human (fatalities, injuries)
economical (damage, business loss etc.)

for exceedance of limit - not provided in standards



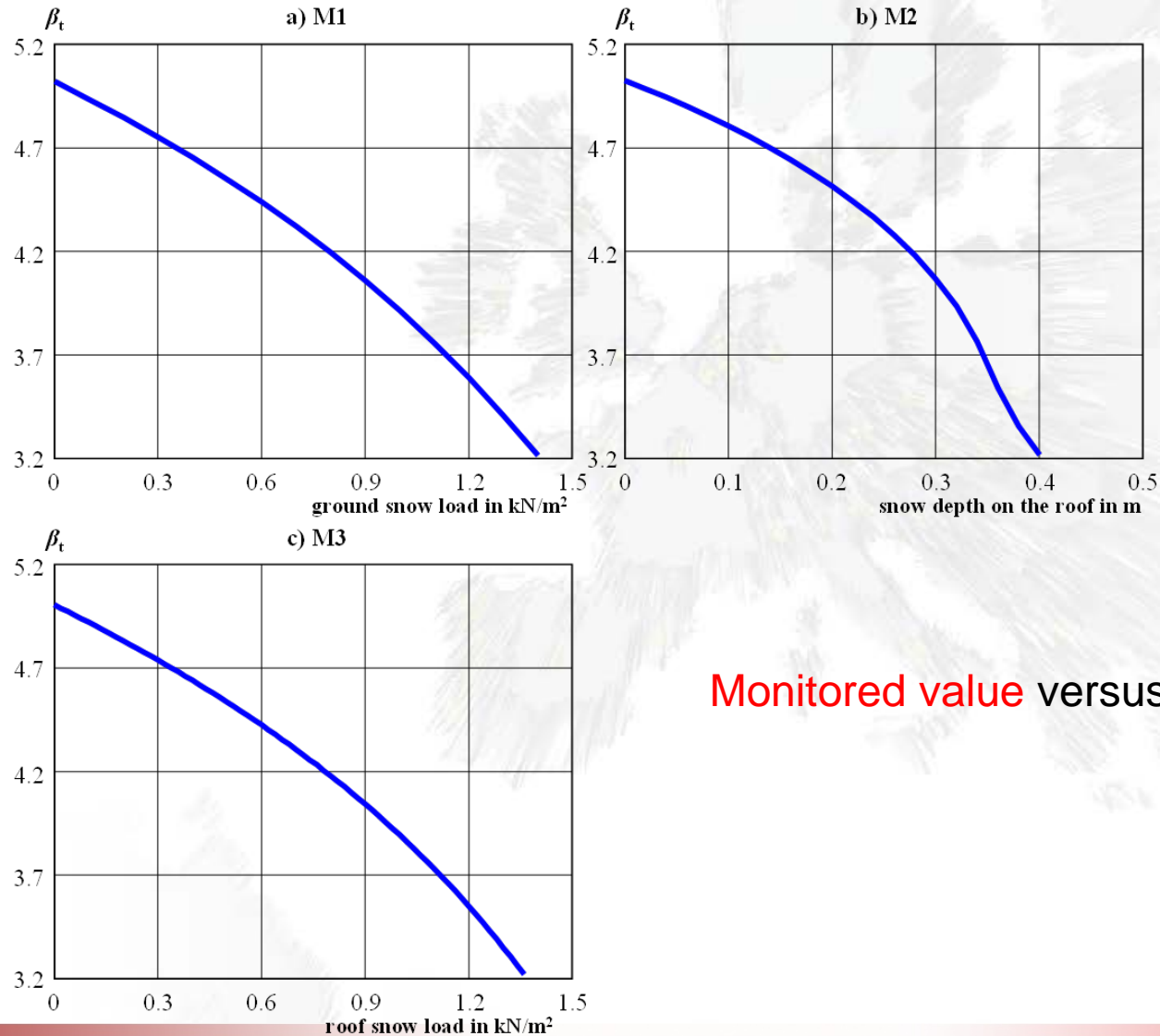
3. Results obtained



C_{tot} (total costs in a reference period and discounted) include:

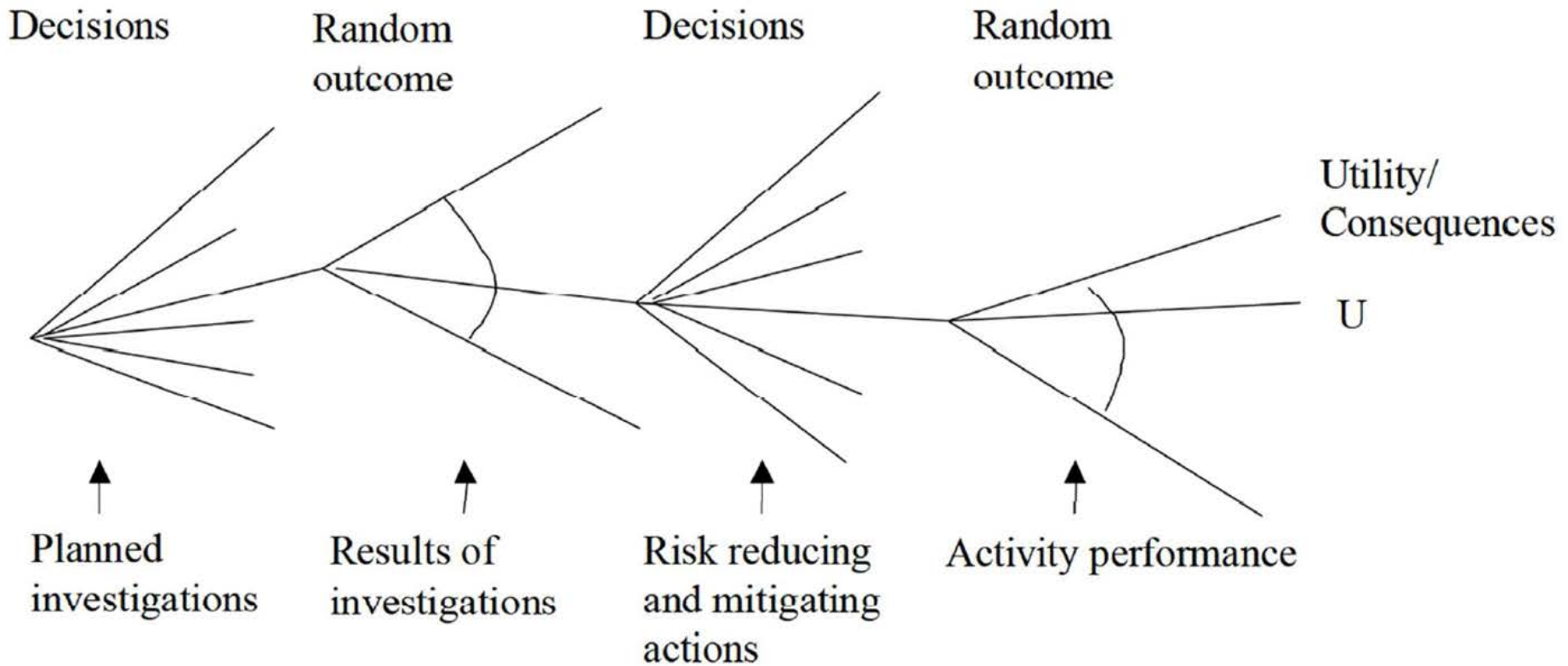
- acquisition costs
- operational costs
- costs of safety measures when limit is exceeded

3. Results obtained



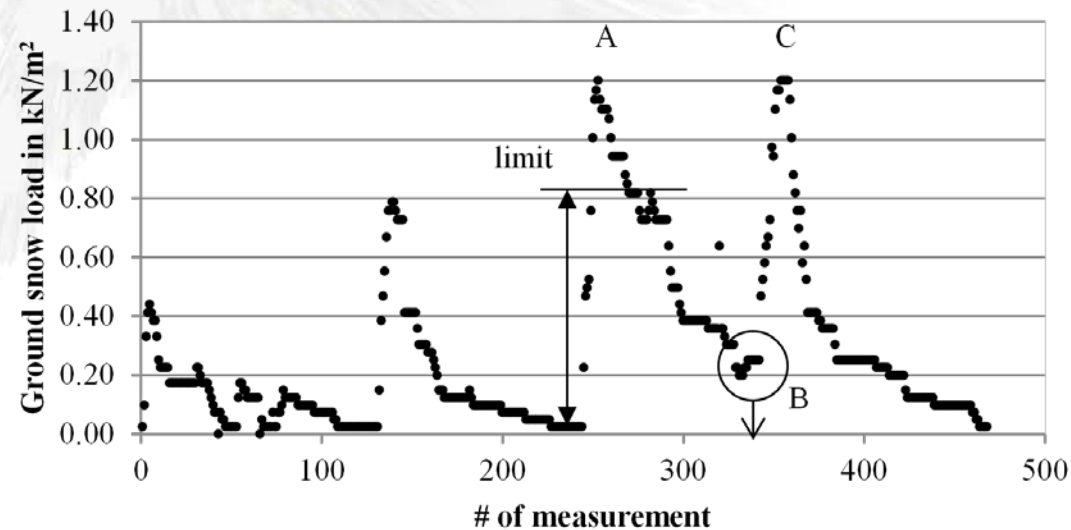
Monitored value versus target reliability

4. Value of the SHM information for the owner/concessionaire



4. Value of the SHM information for the owner/concessionaire

- provides **limit values** for loads corresponding to acceptable risk
- allows for **realtime evaluation** of structure
- supports decisions regarding **safety measures**
- leads to a **more economical solution** compared to **expensive upgrade**
- indicates an **optimal** monitoring strategy
- increases **research knowledge**
- adds to **reputation**
- assists development of standards



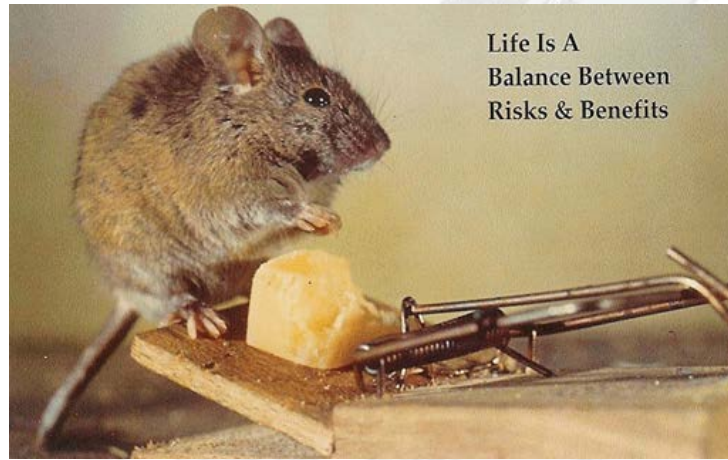
5. Open question addressed to decision makers

Question 1: Existing structures not fulfilling current standards

Question 2: Value of Information for use in practice

Question 3: Estimation of costs of failure





Thank you for your attention

<http://www.cost-tu1402.eu/>

