INDUSTRIAL HERITAGE STRUCTURES

Discussion note for ISO TC98/SC2/WG6

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Significance of the industrial heritage structures

A number of factories, warehouses, power-plants, bridges and other industrial construction works, built since the beginning of the Industrial Revolution, has been registered as industrial cultural heritage worldwide. Such structures are mostly of significant architectural, historic, technological or social value.

The industrial heritage structures often form part of the urban landscape and provide the cityscape with visual historical landmarks. Protection of the industrial heritage structures helps preserve cultural values, avoids wasting energy and facilitates economic regeneration of regions in decline.

Present insufficient attention to systematic recognizing, declaring and protecting the industrial heritage may, however, lead to their extinction. Desired protection of the industrial heritage structures requires a public recognition of the industrial heritage to be equally important as other cultural heritage. Introduction of educational programs and relevant legislation is needed.

Probabilistic assessment of heritage structures

Reliability assessments of heritage structures need to account for significant uncertainties related to actual structural conditions that can hardly be described by simplified deterministic procedures used for structural design. Deterministic assessments may be “over cautious” and may lead to inevitable repairs and losses of the cultural and heritage value. The use of probabilistic methods in the assessment is thus proposed to facilitate:

- Better description of uncertainties related to material characteristics, actions, degradation aspects and modelling,
- Inclusion of results of inspections and tests and the satisfactory past performance in the assessment.

The probabilistic assessment may substantially improve the estimates of the reliability level for heritage structures. It should be based on:

- Models for basic variables determined taking into account the actual situation and state of the structure,
- Target reliability levels that are primarily dependent on costs of safety measures and consequences of failure including loss of the cultural and heritage value.

The target levels may be specified on the basis of the total working-life cost optimisation.

The cost optimisation is aimed to find optimum decision from the perspective of an owner of the structure. However, society commonly establishes limits for human safety. Steenbergen & Vrouwenvelder (2010) proposed to consider the acceptable maximum probability to become a victim of structural failure approximately 10^{-5} per year and derived the target reliability indices to assure minimum human safety. This procedure is adopted here, but the acceptable maximum probability to become a victim of structural failure is considered as 10^{-6} per year in accordance with ISO 2394 (1998); the following target reliability indices are then obtained:

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Low failure consequences: $\beta_{hs} \geq -\Phi^{-1}(t_r\ 1\times10^{-3})$
Medium failure conseq.: $\beta_{hs} \geq -\Phi^{-1}(t_r\ 3.3\times10^{-5})$
High failure consequences: $\beta_{hs} \geq -\Phi^{-1}(t_r\ 3.3\times10^{-6})$

where $\Phi^{-1}(\cdot)$ = inverse cumulative distribution function of the standardised normal distribution and t_r = anticipated remaining working life.

Decision-making based on cost-benefit optimisation

Similarly as for other existing structures, decision-making concerning repairs of heritage structures may be based on balance between the consequences of failure, costs of safety measures and benefit related to use of a structure during a given reference period.
In general the optimisation should include the costs of:

- Foreseen inspection and maintenance,
- Immediate and foreseen repairs (costs related to surveys, assessment, construction, loss of the cultural and heritage value, economic losses due interruptions in use of a structure etc.),
- Structural malfunction (costs of repairs in case of failure, loss of the cultural and heritage value, economic losses, societal consequences etc.).

For consistency, the immediate and future costs need to be expressed on a common basis (using a discount rate).

Estimation of the failure cost is a very important, but likely the most difficult step in the cost optimisation. All the other components of the failure cost should be preferably assessed in monetary terms, which may, however, be difficult. To facilitate this task, JCSS (2006) proposes classification of the failure consequences (societal and economic consequences).

In addition the loss of a cultural and heritage value needs to be quantified. Several methods have been proposed for the assessment of an environmental value of assets, which may be a similar issue to the estimation of the cultural heritage value as indicated by Sanz et al. (2003) and Bedate et al. (2004). These methods include the hedonic price method, the method of contingent valuation and the travel cost method. Application of such methods may facilitate ranking individual or societal preferences with regard to the cultural heritage and help assess public policies of conservation of cultural heritage. It appears that a touristic appeal of a heritage site is an important factor influencing the estimate of the cultural heritage value.

Recommendations for further development of Annex I

The present Annex I to ISO 13822 may be supplemented by notes concerning:

- Importance of the industrial heritage buildings and bridges,
- Advantages of the probabilistic methods in the assessment of heritage structures,
- Methods that may be used in a quantitative assessment of the cultural and heritage value.

References

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