

Advanced assessment of industrial heritage buildings for sustainable cities' development

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Introduction

- **Industrial heritage** - structures of significant architectural, historic or technological value
- Part of **urban landscape**, visual historical landmarks of cityscapes
- **10 000 buildings and bridges** in the Czech Republic
- Insufficient attention to recognizing, declaring and protecting - gradual **extinction**
- Re-use and adaptation – **integration** into an urban lifestyle, protection of cities' heritage
- The **contribution** is aimed to indicate:
 - high architectural and cultural significance of the industrial heritage
 - positive influence of preservation on the sustainable development
 - framework for complex reliability assessment

Importance of protection

- Protection, adaptations and re-use positively contributes to the **sustainable development**:
 - preservation of the **cultural values**
 - **recycling** of resources and avoiding wasting energy
 - facilitating the **economic regeneration** of areas in decline.
- **Ecological** and **social** contexts
- **Importance** increasing due to:
 - shortage of energy
 - economic crisis
 - environmental protection.
- **General significance** - policy of the sustainable development.

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Overview of initiatives concerning the protection

- Protection – **multidisciplinary topic** (historical, architectonic, civil engineering and ecological aspects)
- The Czech Republic: urgent issue after 1990 (industrial production reduced, numerous factories closed)
- **International Committee on the Conservation of the Industrial Heritage** TICCIH founded in 1978
- **Research Centre for Industrial Heritage** (CTU in Prague):
 - database of Czech industrial monuments
 - search for new uses
- CTU in Prague and the University of Applied Sciences in Ås (Norway) - **Assessment of historical immovables** - structural assessment of the industrial heritage structures

General aspects of the assessment

- Minimisation of construction interventions (respect of the original conception, durability of materials), but *sufficient reliability*
- Social and cultural aspects - loss of *cultural and heritage* values
- Economic aspects - *additional costs* to increase reliability
- *Sustainable development* - recycling of materials
- *Deterministic* design *procedures conservative* (expensive repairs, losses of cultural and heritage value)
- *Probabilistic procedures* improving the reliability assessment by:
 - better description of uncertainties
 - facilitating inclusion of the results of inspections and testing

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Probabilistic assessment

$$p_f(t_D) = P\{Z[\mathbf{X}(t_D)] < 0\} \leq p_v \quad \beta = -\Phi^{-1}[p_f(t_D)] \geq \beta_t$$

- *Resistance - decreasing function, time-variant loads*
- *New information* related to structural conditions:
 - inspections, measurements (deterioration, materials, geometry)
 - satisfactory past performance
- Target reliability:
 - *ISO 2394* - moderate failure consequences, moderate costs of safety measures - $\beta_t = 3.1$
 - *empirical models* $\beta_t \approx 2.7 - 3.4$
 - *minimisation* of the total working-life *cost* (inspections, maintenance, repairs, failure consequences)

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Examples of successful reconversions



School building, de Bouw et al. Structural analysis of two metal de Dion roof trusses in Brussels model schools. STREMAH XI, 2009

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Examples of successful reconversions



Residential houses in Manchester, Fragner, B. Approaches to protection of the industrial heritage in the Czech Republic (in Czech). Stavebnictví, IV(01/2010), 2010.

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Examples of successful reconversions



Residential houses in Wien, Fagner, B. Brownfield in relation to industrial heritage (in Czech). Vesmir, 84 (leden 2005), 2005.

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Conclusions

- **Protection** of the industrial heritage contributes to the sustainable development (cultural values, avoiding wasting energy, regeneration of declining areas).
- Insufficient attention to recognizing and protecting the industrial heritage may lead to its **extinction**.
- Desired protection requires a public recognition of the industrial heritage to be **equally important** as any other cultural heritage.
- **Educational programs** and **relevant legislation** are needed.
- **Significant uncertainties** related to actual structural conditions can hardly be described by simplified design procedures.
- **Probabilistic methods** allow to better consider uncertainties, results of inspections and tests and satisfactory past performance.

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eea grants
Iceland liechtenstein norway

norway grants

Supported by a grant from
Iceland, Liechtenstein and Norway
through the EEA Financial Mechanism
and the Norwegian Financial Mechanism

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Thank you for your attention.