# Indicators for Serviceability for Low-Carbon Building Slab Types

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## Abstract

Multistorey and high-rise buildings imply a considerable amount of carbon intensive material in their structure and slab floors. The latter are the scope of this paper. Not only structural efficiency and construction cost need consideration, but also energy efficiency, emissions, resource extraction and building flexibility along time. Besides functionality, slab floor components may respond to resource depletion and GHG minimization whilst ensuring cost-effectiveness. As there is not a unique solution for an optimal type of slabs thus we provide a suite of criteria and subcriteria. Accordingly, a multicriteria decision matrix is needed to select the best choice. A group of experts will rank and validate the proposed structure to know how much relevant each one it is for the decision maker.

**Keywords:** structural efficiency, building slabs, lifetime engineering, AHP, MCDM.

## 1 Introduction

Aware of Life Cycle Cost of buildings, the structural engineering practice still has not regular applicability. There is a need for bridging the gap between design and sustainability assessment. Life Cycle Impact analysis (LCI) provides an objective set of impacts, but there is not a direct way to dimension low carbon structures for as long as service life requirements other than through estimation [1]. Current research leads towards low carbon slabs dimensioning through optimization algorithms from an already selected choice. A number of research studies highlight the power of optimization to minimize costs in concrete volume and reinforcement of building frames [2], beams [3,4] and slabs [5,6]. This practice make us learn about cost-efficient solutions. Engineers remark the need for in depth environmental assessment criteria at design level. When there is a range of valid options for a determined span length, still criteria for the optimal choice remains prior to LC inventory analysis for each one.

## 2 Objectives of the paper

Main objectives of this paper are to debrief a set of criteria to be considered for environmentally efficient structural design of slab floor systems; as well as to provide a valid hierarchy for evaluation according to multicriterion assessment methods. A first description of assessment criteria obtained from a desk research lead us to a hierarchical structure. There is no linear dependence among a variety of relevant criteria most efficient decision are not trivial to obtain at early stages.

## 3 Commonly used slab systems

Current slab systems are primary elicited according to site constraints and project requirements. It is well known that precast options are often dismissed in Spain due to accessibility reasons, although they are considered cost-effective due to fewer on-site labor costs. There is a range of regular used options that certain hesitation among options is expected in dimensioning. However they may imply different environmental burdens. Despite the broaden use of one-way tie-beams labor costs some EU countries definitely support construction technologies that reduce on site work by better integration in manufacturing. Recent developments step forward by integration of both the upper and lower utilities level within the design slab height [7,8], for which a coordinated project delivery approach among contractors and engineers is needed [9]. As cost premium of BIM implementation is a barrier until integrated design process has a sound establishment. Current knowledge on construction scheduling optimisation design scheduling activities…

One-way slab types considered in this study are shown according to regular span length (Figure 1). Precast or prestressed joists will be considered for comparison due to their economy and broader use due to a generalization of the integral formwork system that reduce safety risks. Two-way flat plates will be also computed in a separate group to find Pareto optimal according to a set of criteria.

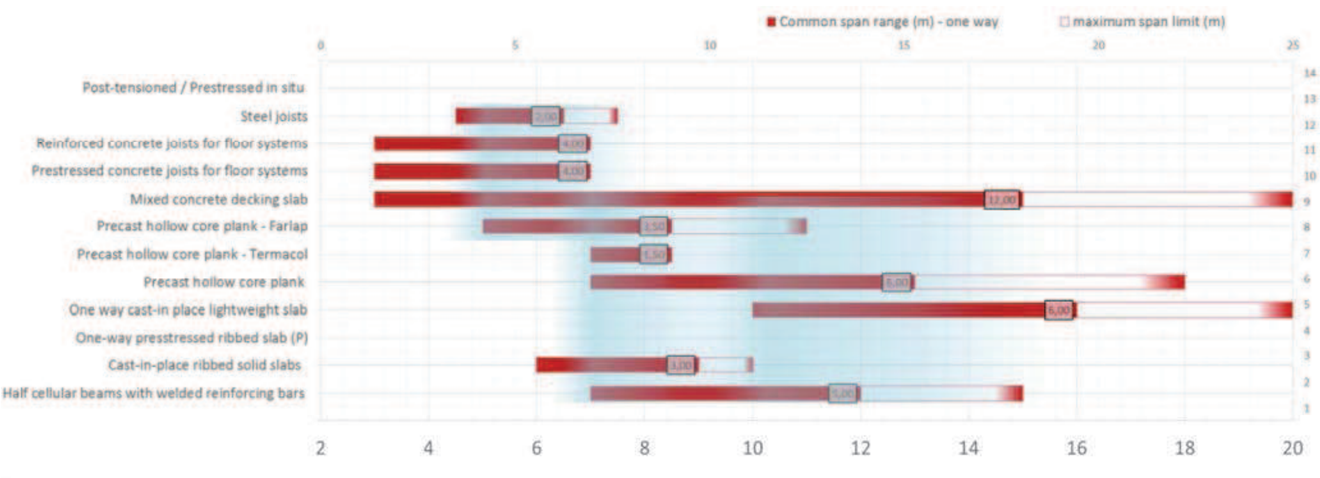


*Figure 1 Regular span lengths for building slab types*

## 4 Methodology for selection

Multicriteria assessment methods (MCDM) is chosen to select sustainable criteria to assess optimality of feasible options. MCDM has been applied in several fields in construction engineering [10]. Optimization techniques to minimize structural weight and construction cost focus on single or multiple objective functions to reduce carbon intensive materials in building frames [2,11]. Pareto frontier is considered a useful tool to choose among the best values for feasible solutions [12]. Several authors use it to find optimal variables of one way slab floors. We draft a criteria hierarchy and rank criteria weights through Analytical Hierarchical Process (AHP), a MCDM method being widely used in engineering (Pons & de la Fuente 2013). Weighing factors must be indicated by a consensus of experts. The hierarchy will outline a quantitative way to quantify intangible features for assessment slabs which currently do not considered environmental impacts as a decision criteria.

## 5 Assessment framework

Authorities need to envision long term costs related to inspection, maintenance and building facilities replacement [15,16]. Recent approaches consider upgrading of involved structural elements include long-term burdens. First approaches on MCDM for concrete infrastructures positively evaluate the lifetime extension based on the influence over the environment during the construction activity [17]. As for the lifetime durability, European standard roadmap CEN/TC-350 supports the inclusion of integrated lifetime reliability control approaches (statistical based risk analyses) rather than awarding such lifetime extension; there is no reason to lengthen lifetime beyond prescription given that increased design lifetime is little so it is considered as residual value of life cycle [15,18]. In agreement to the lifetime engineering framework [15,19] additional design criteria besides static and dynamic limit states are considered in a holistic sustainability assessment. Therefore, accessibility to technical equipment on benefit for future utilities maintenance becomes a design criteria at the structural design level as it affects prospective operational costs. Differences among structural limit states (LS) are thereon defined by the CEN/TC-350 EU standard (Table 1).

| Mechanical LS | Durability LS | Obsolescence LS |
|---|---|---|
| Design strength | Design life | Design life |
| Static or dynamic loading | Environ. degradation load | Obsolescence loading |

*Table 1 Differences in structures limit states*

## 6 Criteria reviewed

Several hard criteria are relevant for contractors and engineers as well as functionality criteria are depicted showing that complex interaction between the building physics and structural engineering needs from early stage collaboration.

### 6.1 Constructability and performance

Several authors considered constructability issues among relevant factors of decision support systems [20], due to the need for fast elevation in multistorey buildings. Site accessibility and schedule are relevant considered as qualitative measurements in most project decisions. Some authors remark that intensive labor requirements and complex construction affects quality and performance [21,22]. When there is a leasing contract for machinery shoring and striking operations are less preferred; shore removal is time consuming. The limit time before one slab is ready before the elevation of the uppermost slab is often considered a constraint for building erection. Load transfer during construction, influences the young structure and safety during the construction process [23].

### 6.2 Structural efficiency

The heavier the magnitude of transferred dead load of the slab floor, the heavier the framing main structure and load transfer to soil, meaning higher costs and environmental burdens in terms of weight and material volume aligns. Postensioned slabs evidence less environmental impact since a volume of concrete is used, provided that such reduction means fewer Clinker in cement dossage [1].

Vibrations and surface cracking are major concerns for the user comfort, this are as consequence of material density and continuity among the slab layers. Vibrations may occur in mixed concrete decking slabs and precast planks, then limit values of standard codes apply.

### 6.3 Flexibility and Functional design

Besides the need for minimal slab overall thickness to reduce story height and therefore building height, functional criteria during lifetime should be considered. Structural engineers strive to integrate slabs with facilities [7,8].

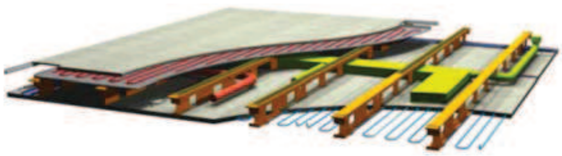

*Image 1 Slimline ® floor system. Radiant panel heating/cooling circuit into hollowcore plank*

Thermal insulation is a relevant criterion during occupancy stage, thus prescriptive limits apply. Some authors analyzed transmittance across slab density gradient of one-way ribbed slab elements concluding that higher slab thickness do not present a substantial thermal barrier; insulation potential it is merely within the lightweight element. The thermal parameter is mainly dependent on the effective density of the overall system, which is obtained from standards. The situation for sound insulation is similar; in precast slabs, it is the use of concrete topping and insulation layer below pavement which determines sound insulation. Impact strength – responsible for noise reduction- depends of slab thickness and material stiffness.

### 6.4 Social impacts

Sustainability index for concrete structures (MIVES), first approached the social dimension by considering noise levels in the neighborhood as assessment criteria and labor safety based on probability and severity of risks. Labor specialization improves workers professional satisfaction a social aspect of workers but still is not considered in assessment of building and civil engineering. Adverse climatology in Northern Europe the reduced working hours under such conditions in favor of increased preassembling in manufacturing plants. The reduced working hours under adverse climatology are beneficial for labor staff. The level of specialization and manufacture externalization to plants is still not assessed in tools as social benefit.

### 6.5 Environmental impacts

This criterion aims to account for the objective measurement of environmental burdens. Traditionally unconsidered and hindered by manufacturing cost, raw materials extraction and transportation burdens imply considering new variables in the design system.

***Resource depletion***

Valorization of materials is still not widely considered despite the proven results outlined in literature [24–26].

***Primary Embodied Energy and Global Warming***

Ordinary Portland Cement (OPC) amount (kg) and distance to production plant (km) are considered the most important contributing factors to global warming by assessment methods [14] and tools (SIMAPRO) due to the impacts of manufacturing and transportation emissions and embodied energy. Thus, the amount of substituents of OPC such as fly ash and blast furnace is positively considered by assessment tools. Transportation costs and emissions are not negligible; we must comply not only with cement manufacturing but bear in mind usually longer distances from precast and additives plants.

***Waste generated by deconstruction or demolition***

Unless there is a separation of plaster from other materials of multi-layered exterior walls or mixed floor slabs are disadvantageous in separation for recycling. It is difficult to separate plaster from multi-layered exterior walls demolition so valorization of materials becomes cost-intensive. Therefore, considering demolition stage, single layer exterior walls may be evaluated as low-carbon intensive within demolition stage.

### 6.6 Cost Estimation

Cost is, by far, the most considered criterion chosen while selecting a slab solution. However, this has changed during recent years due to increasing interest on lifetime and environmental costs. Several construction costs are directly related to stability during construction and functional requirements. Focus on construction schedule planning, safety and construction costs may hinder maintenance, repair and rehabilitation costs. Those costs triggered by obsolescence of the structures [18], these are of major interest for the building property and users.

## 7 Criteria structure

The reviewed criteria can be gathered into four main groups:

1. *Constructability and performance;*
2. *Structural efficiency and functional design;*
3. *Environmental impacts;*
4. *Overall lifetime costs.*

### 7.1 Constructability and performance

Buildability on site is a key factor that will determine feasible solutions according to transport planning to site, special material and stock allocation. Therefore a decision tree that differentiate among precast and on site options will precede the multicriteria model.

| Criterion | Subcriteria | Indicator |
|---|---|---|
| **Buildability on site** | Complexity of site programming | High / Medium / Low |
| | Delay until operative uppermost slab is operative | time per work unit (hour/ |

m2)

*Table 2 Subhierarchy of Buildability factor*

Our aim is to include the level of specialization required as qualitative criteria within the buildability factors because it is beneficial for professional satisfaction, thus being a step forward for the assessment of the social dimension. Prefabrication degree is also a criteria when applicable, as well as construction speed, which are directly related to construction costs due to labor specialization. When bottlenecks and risk of delays on schedule are present in on site alternates, the relative importance of reinforcement placement, shore removals or welding works will account.

## 7.2 Structural Efficiency and functionality

As previously stated, the influence of material weight on the structure is not considered, otherwise impacts and cost would not be valid criteria because both are weight-dependant. Load bearing capacity of the slab and structural behaviour (stiffness, strengh and vibration) are considered according to relevant standard in force.

The slab overall heigth and the level of stiffness are the parameters to compare among alternatives. The former affects clearance height space and overall building heights. Pronounced overhangs of girders, floor ceiling and abacus hinder passage facilities. The latter consider the influence of dead load on bending strengh. Limitations on active deflection determine the boundary conditions. The level of stiffness is determined by the difference between limited and estimated active bending.

| Criterion | Subcriteria | Indicator |
|---|---|---|
| **Structural Efficiency** | Slab overall thickness (with and without ceiling) | cm |
| | Level of stiffness | cm |

*Table 3 Subhierarchy of structural efficiency factor*

Acoustics and thermal insulation will not be considered for expert opinion because prescriptive standard codes stablish comfort values. Our aim is to compare structural alternatives regardless variations on thermal insulation.

Precast one-way options include in-built insulation elements (Figure 2), which is time saving. The analysis of such kind of precast slab types would need to jointly consider the slab thickness and effective density of the whole piece. Just on some alternatives the weightings of these criteria would be advantageous for comparison.

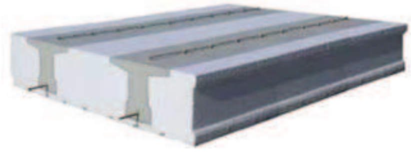

*Figure 2 Termacol ® Concrete and polystyrene plank for forming slabs*

## 7.3 Environmental Impacts

National material databases provide total primary energy use and emissions for the diverse materials. The subcriteria considered are the table below:

| Criterion | Subcriteria | Indicator |
|---|---|---|
| **Lifecycle Impacts** | Primary Embodied Energy | MJ / kWh per work unit |
| | Resource depletion - Raw material (%) | (%) kg/m3 |
| | Potential for reuse and recycling | kg of production per kg involved |
| | Contribution to global warming - CO2 emissions | kg CO2 /t |

*Table 4 Subhierarchy of environmental impacts*

## 7.4 Overall Costs Estimation

Construction costs and maintenance costs are considered. To simplify the task of including maintenance costs (as long-term risk within the lifetime engineering approach) we include this factor as a subcriterion within the overall cost criteria. Maintenance costs are provided from accessible databases.

| Criterion | Subcriteria | Indicator |
|---|---|---|
| **Lifecycle Costs** | ∑ Construction costs (material, transport) | Euro / work unit [+ Euro/ ton $CO_2$] |
| | ∑ Estimated operational | Euro / work unit |

| | |
|---|---|
| | costs on life time |

*Table 5 Subhierarchy of overall lifecycle costs*

Higher carbon intensive materials supply means higher costs due to emission trading needs, thus we also consider auctioning value of $CO_2$ allowance.

## 7.5 Criteria not considered

It is hard to predict soft criteria as safety risks, obsolescence rates and maintenance costs. According to CEN/TC-350 deterioration processes should be considered through risk-based analysis. We do not include those subcriteria it in the current hierarchy due to complexity measurement. As there is no objective way to forecast cost overruns due to on site complex programming, we do not consider it at this point. According to the review we propose a preliminary hierarchical structure in Figure 3.

| Criteria Requirements | | Subcriteria | Subcriteria considers |
|---|---|---|---|
| CONSTRUCTABILITY ON SITE | 1 | Speed of construction (provided that the slab construction affects the critical path) | Casing and uncasing formwork, shore removals and welded connections if bottlenecks on schedule |
| | 2 | Specialisation on building technology required for the elicited option | Adaptation to local construction techniques |
| | 3 | Prefabrication level on site | Considers the demanding level required for realisation |
| STRUCTURAL EFFICIENCY | 4 | Slab overall thickness (affects clearance height space and overall building heights) | Pronounced overhangs of girders, floor ceiling and abacus hinder passage facilities. |
| | 5 | Stiffness (as the difference between limited and estimated active bending) | Affection on non-structural elements, sound insulation (acoustics) and undesired vibrations |
| IMPACTS DURING LIFECYCLE | 6 | Primary Embodied Energy in manufacturing and construction | Embodied Primary Energy |
| | 7 | Resource depletion - Raw material (%) | Raw material Extraction - Recycling content |
| | 8 | Potential for reuse and recycling | Recyclable Content (%) - post consumption (MFA) |
| | 9 | Contribution to global warming | Atmospheric CO2 emissions |
| LIFECYCLE COSTS | 10 | ∑ Construction costs (material, transport) | Includes specialized labor and transportation costs |
| | 11 | ∑ Estimated operational costs on life time | Refurbishment and maintenance estimation. Deterioration processes under uncertainties |
| | 12 | Estimated demolition costs at end of life | |

*Figure 3 Hierarchy of requirements and subcriteria proposed*

## 7.6 AHP as decision making method

Analytical Hierarchical Process, AHP henceforth, a consensus methodology to select the best choice according to a set of criteria and subcriteria. AHP process is used when:

- A pair-wise comparison is preferred to prioritize between different alternatives;
- Soft aspects (qualitative) prevail over hard ones (quantitative) in some decisions;
- The accuracy of a measurement is less important than the relative importance among all involved criteria.

The steps of the process are:

1. Elicitation of a group of experts in the field of structural engineering from Europe and US.
2. Launch of an online survey to ask for criteria relevance according to their knowledge and expertise. The questionnaire contextualize the expert within the methodology. Respondents are provided with a detailed visual case study of the alternatives. By using Likert scales (1-5), pair-wise comparisons among criteria allow to obtain the relative importance for each set of subcriteria.
3. The priority vector of weights is obtained from pair-wise comparisons for each expert. For every requirement and subcriteria we obtain a sample of expert preferences or weights ($w_{ij}$), where $i$ is the expert (1 to $m$) and $j$ the criteria ( 1 to $n$). The mean values from each criteria constitute the weighting factors of the hierarchy ($w_j$). The definition of the value function is defined for the alternative $k$ as:

$$V_k = \sum_{j=1}^{n} V_{j,k} \cdot w_j \qquad (1)$$

Where *n* is the number of indicators from the assessed criterion. As criteria are measured through different units, normalization of the priority vector of the alternatives is necessary.

4. Assessment of alternatives. For the proposed alternatives grouped by one-way, two-way and on site, precast, we compute all feasible solutions according to USL and SSL.
5. Unfeasible solutions are dismissed so just the remaining factors (costs, environmental burdens, qualitative criteria and energy).
6. Computation of optimality function for each alternative, according to length span. Pareto optimal values will graphically show the best options confronting one criteria to one another, i.e., cost versus embodied energy. A variety of expected and unexpected conclusions is expected, i.e., the progression of impacts versus costs or if whether a solution is always the optimal for a range of parameters.

## 8 Discussion and further analysis

Pair-wise comparisons are gathered at the moment of this submission, results are expected to enlighten a reliable criteria weighting set. Because of different professional profiles and experience results are expected to respond to different interests. Concluding remarks highlight that the relevance on construction costs while long term would remain in a secondary level. Concluding remarks highlight that environmental burdens lead cost is still the objective factor to minimize.

## 9 Acknowledgements

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## 10 References

[1] García-Segura T, Yepes V, Alcalá J. Life cycle greenhouse gas emissions of blended cement concrete including carbonation and durability. Int J Life Cycle Assess. 2013 Jul 4;19(1):3–12.

[2] Paya-zaforteza I, Yepes V, Hospitaler A, González-vidosa F. CO2 -optimization of reinforced concrete frames by simulated annealing. Eng Struct. 2009;

[3] Torres-Machi C, Yepes V, Alcala J, Pellicer E. Optimization of high-performance concrete structures by variable neighborhood search. Int J Civ Eng. International Journal of Civil Engineering; 2013 Jun 15;11(2):90–9.

[4] Yepes V, Martí J V., García-Segura T. Cost and CO2 emission optimization of precast–prestressed concrete U-beam road bridges by a hybrid glowworm swarm algorithm. Autom Constr. 2015 Jan;49:123–34.

[5] Huang L, Mensinger M. Optimization based preliminary structure generation for early stage design estimation of composite office buildings. 2014;2–7.

[6] Mensinger M. Optimization of sustainable office buildings in steel using genetic algorithms. Nordic Steel Construction Conference. 2012.

[7] Mensinger M, Fontana M, Frangi A. Development of a composite slab system with integrated installation floor and increased material-efficiency. 2010;

[8] Frangi A, Knobloch M, Raveglia E, Fontana M, Mensinger M. Composite Slab with Integrated Installation Floor Using Cellular Beams (ASCE).

[9] Porwal A, Hewage KN. Building Information Modeling (BIM) partnering framework for public construction projects. Autom Constr. 2013 May;31:204–14.

[10] Jato-Espino D, Castillo-Lopez E, Rodriguez-Hernandez J, Canteras-Jordana JC. A review of application of multi-criteria decision making methods in construction. Autom Constr. Elsevier B.V.; 2014 Sep;45:151–62.

[11] García-Segura T, Yepes V, Alcalá J, Pérez-López E. Hybrid harmony search for sustainable design of post-tensioned concrete box-girder pedestrian bridges. Eng Struct. 2015;92:112–22.

[12] Yepes V, García-Segura T, Moreno-Jiménez JM. A cognitive approach for the multi-objective optimization of RC structural problems. Arch Civ Mech Eng. Politechnika Wrocławska; 2015;1–13.

[13] Pons O, Aguado A. Integrated value model for sustainable assessment applied to technologies used to build schools in Catalonia, Spain. Build Environ. Elsevier Ltd; 2012 Jul;53:49–58.

[14] Pons O, de la Fuente A. Integrated sustainability assessment method applied to structural concrete columns. Constr Build Mater. Elsevier Ltd; 2013 Dec;49:882–93.

[15] Sarja A. Deliverable 3.1 Generic description of lifetime engineering of buildings, civil and industrial infrastructures. Engineering. Espoo, Finland; 2005.

[16] EN 16309:2014. Sustainability of construction works - Assessment of social performance of buildings - Calculation methodology. AFNOR; 2014.

[17] Del Caño A, Gómez D, de la Cruz MP. Uncertainty analysis in the sustainable design of concrete structures: A probabilistic method. Constr Build Mater. 2012 Dec;37:865–73.

[18] Bamforth P, Alisa M. Probabilistic approach for predicting life cycle costs and performance of buildings and civil infrastructure. 2003;

[19] Landolfo R, Cascini L, Portioli F. Sustainability of steel structures: towards an integrated approach to life-time engineering design. Front Struct Civ Eng. 2011 Sep 5;5(3):304–14.

[20] Yang J, Ogunkah ICB. A Multicriteria Decision Support System for the Selection of Low-Cost Green Building Materials and Components. J Build Constr Plan Res. Scientific Research Publishing; 2013 Dec 3;01(04):89–130.

[21] Chen Y, Okudan GE, Riley DR. Sustainable performance criteria for construction method selection in concrete buildings. Autom Constr. Elsevier B.V.; 2010 Mar;19(2):235–44.

[22] Rincón L, Castell A, Pérez G, Solé C, Boer D, Cabeza LF. Evaluation of the environmental impact of experimental buildings with different constructive systems using Material Flow Analysis and Life Cycle Assessment. Appl Energy. Elsevier Ltd; 2013;109:544–52.

[23] Moragues JJ, Catala J, Pellicer E. An analysis of concrete framed structures during the construction process. Concr Int. 1996;18(11).

[24] Mercante IT, Bovea MD. Life cycle assessment of construction and demolition waste management systems : a Spanish case study. 2012;232–41.

[25] Knoeri C, Sanyé-mengual E, Althaus H. Comparative LCA of recycled and conventional concrete for structural applications. 2013;2006:909–18.

[26] Collins F. Inclusion of carbonation during the life cycle of built and recycled concrete : influence on their carbon footprint. Int J Life Cycle Assess. 2010;549–56.

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**Geneva, Switzerland**

# Structural Engineering


**Sept. 23–25, 2015**

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IABSE is a fellowship of structural engineers operating on a worldwide basis, with interests in all types of structures, in all materials.

It acts to improve our knowledge and understanding of the performance of structures. Its members represent structural engineers of all ages, employed in design, academia, construction, regulation and renewal. Many IABSE members occupy senior roles based on a history of personal achievement.

The mission of IABSE is to exchange knowledge and to advance the practice of structural engineering worldwide in the service of the profession and society.

## IABSE's objectives are:

- to promote cooperation and understanding among all those concerned with structural engineering and related fields by a worldwide exchange of knowledge and experience
- to encourage awareness and responsibility of structural engineers towards the needs of society
- to encourage actions necessary for progress in structural engineering
- to improve and foster cooperation and understanding between organisations having similar objectives

To fulfill its mission, IABSE organises conferences, publishes a high quality journal, *Structural Engineering International* (SEI), publishes books reflecting the work of its Technical Groups, creates Working Groups as required by new needs and technological progress, offers activities within the National Groups of IABSE, supports engineers at the beginning of their careers with a Young Engineers programme, and presents annual Awards in recognition of outstanding contributions in the field of structural engineering.

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# Preface

IABSE has, since its creation by visionary Swiss Engineers in 1929, fulfilled a very important and highly commendable purpose:
To create a global forum for international exchange between structural engineers from all over the world, - irrespective of political, religious and racial origins, and irrespective of functions at owner organizations, universities, consultants, contractors and suppliers, - with the sole purpose of sharing the common interest and together advancing the art of structural engineering for all relevant materials, and all for the benefit of the society.
This fundamental purpose is unchanged and still valid today, 86 years on.
However, the means of communication and exchanging new ideas has changed in a way that nobody could have imagined when IABSE was founded: from time consuming, expensive and strenuous travel, and communication by surface- or airmail, sometimes restricted because of partly closed country regimes, - into now instantaneous global communication such as email, teleconferences, drop box and the like, not to mention all the new social media.
Such change must inevitably lead to a review of the way IABSE operates in order to create value for its members and Society.
Furthermore, the role of structural engineers in developing the future society has never been more important, and yet not recognized as it should:
The general public focuses primarily on politicians, financial houses, developers and other decision makers, as well as architects, because they hit the news media with big headlines most often, whereas the important, indispensable work of the structural engineer remains hidden as a back office commodity.
The fact is, however, that without the structural engineer's work, most of the built environment and infrastructure would not be possible.
The new IABSE Strategy, which is now under implementation, is meant to address the above two issues:
That is, the indispensable role and responsibility of Structural Engineers in developing the society for future generations as the important piece in the global puzzle, in cooperation with other professions, as well as modern, value-creating interaction amongst Structural Engineers globally, through meaningful conferences with relevant debates and discussions, making it worthwhile to meet physically at conferences.
The purpose of the IABSE Conference in the global city of Geneva is to address these issues that are so fundamental for future generations of Structural Engineers, and, not least of all, to the ultimate benefit of society in general. The conference has been planned together with a Scientific Committee to include debate and discussion sessions focusing on four global challenges affecting the work of Structural Engineers. It is the hope that the sessions will lead to the formation of many new Working Groups that will take up the challenges identified at the conference with the goal of presenting their findings and results at IABSE events in the near future.
I wish you a very warm welcome to Geneva and hope you will leave Geneva full of inspiration and energy to make your contribution to the structural engineering profession and the development of IABSE—the ultimate forum for us.
Thank you to the Scientific Committee lead by Eugen Brühwiler as well as the IABSE Secretariat for their great work.

On behalf of the Lead Team,

Klaus H. Ostenfeld, Former IABSE President, Chair of the Lead team

# Vision

**Structural Engineering – Providing Solutions to Global Challenges**

The Geneva 2015 IABSE conference is designed to showcase the significant impact that structural engineers have on society. The conference focuses on structural engineering as a key industry for addressing global challenges and ensuring sustainable growth of our society by providing a high quality built environment. Structural engineering is a central solution provider with interfaces to many other disciplines and dominant in its role and responsibility.
Building upon the technical expertise and authority of IABSE as the prime international organisation of structural engineers, the conference explores the contributions that structural engineering can make to solving major problems of today and the future.
With Geneva being the heart of numerous international and humanitarian associations there could not be a better place to discuss these global challenges. Four Global Themes have been carefully selected and form the central pillars of the technical programme. These themes are introduced by high-level, visionary debates and keynote speakers and subsequently explored in depth by different style sessions in order to best address the complex issues and engage with the wider engineering community and key decision makers.
The conference programme has been developed on the basis of topics and sessions proposed within the global themes by the IABSE members and participants in a dynamic and interactive process. Subsequently, many contributers have become session facilitators with a high degree of influence on the actual contents of the sessions. This is the first time the conferences contents has been directly audience generated with a vision of maximizing the relevance to and engagement of the conference participants.
Besides the Global Themes, the conference programme features traditional technical sessions with a wide scope as well as a diverse mixture of session formats such as debates and workshops in order to accommodate different content and intent. The aim is to create a stimulating and participative event with novel approaches for knowledge sharing and a maximum of interaction between participants. The sessions are designed to catalyse the discussions and provide a tangible output of the conference, with the goal of leading to new IABSE activities well beyond the Geneva conference.

**Welcome to the new conference format – welcome to Geneva!**

**The Lead Team**