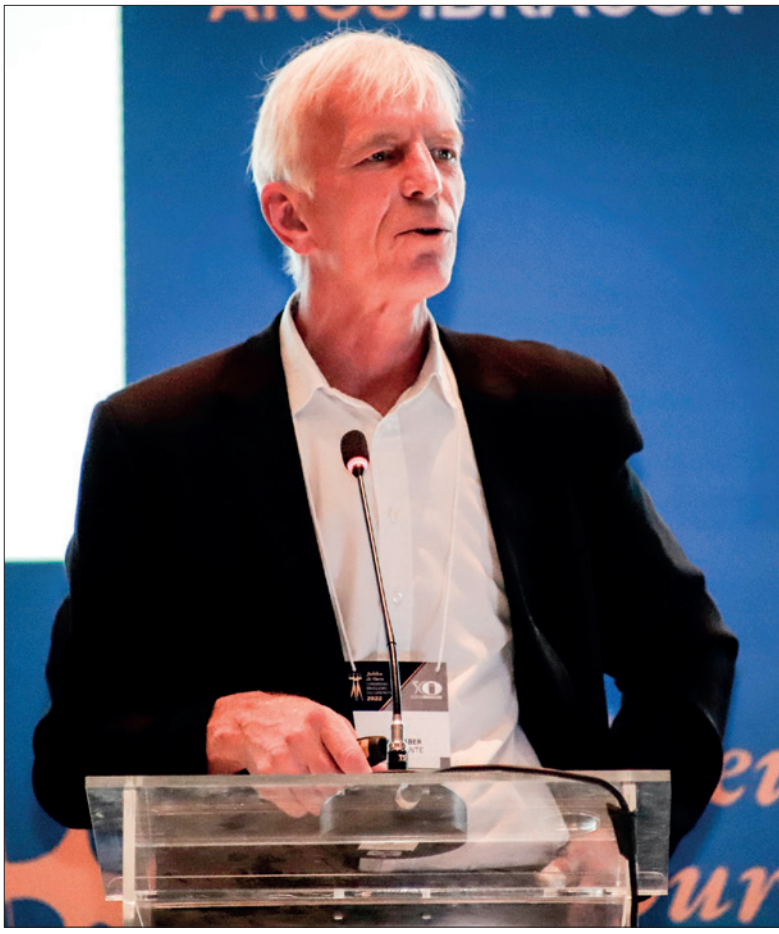
Michael **Havbro Faber**



Michael Faber é professor no Departamento de Ambiente Construído na Aalborg University, na Dinamarca. Suas pesquisas voltam-se ao desenvolvimento de modelos probabilísticos que auxiliem na governança de riscos, resiliência e sustentabilidade do ambiente construído.

Nesta entrevista, Faber propõe uma mudança de paradigma na indústria da construção, de modo que seus processos deixem de ser regulados por prescrições e passem a ser baseados em critérios de desempenho, aos quais ele acrescenta as emissões de dióxido de carbono.

Para ele, deverá haver uma coordenação global do setor que nos diga onde, quando e como construir, de modo que o orçamento global de carbono que nos resta seja eficiente e equitativamente alocado.

IBRACON **TELL US WHY YOU CHOSE CIVIL ENGINEERING AND WHAT CIRCUMSTANCES LED YOU TO PROBABILISTIC MODELING OF SYSTEMS WITH APPLICATIONS TO GOVERNANCE AND MANAGEMENT OF RISKS, RESILIENCE, AND SUSTAINABILITY IN THE BUILT ENVIRONMENT?**

| **MICHAEL HAVBRO FABER** | To be completely honest, the decision to pursue a university degree in civil engineering was not part of a coherent career plan. Actually, at that time I was also equally considering an education as a veterinarian, and to study psychology for some reason also attracted me. I was very much in doubt. Like many others of my peers - and also students now in the same situation - I believe I was a rather immature young man trying to find the right way ahead for my future life, with very little information on what that really means. Indeed, it was also quite late in my studies – maybe around the sixth semester that I found my deep interest in civil engineering and a strong motivation to try to do things better – that has never really left me again. Offshore engineering at that time was a new and challenging topic in Denmark as we were in process of developing infrastructure for offshore oil and gas production. In that context, at the time still relatively young research field of structural safety appeared super challenging and interesting to me. In hindcast – that combination not only became the topic of my Master thesis but also laid the foundation for what became my career in academia and industry.

It is important to note that along the way I was very fortunate to get the opportunity to work with many inspiring personalities that surely all have contributed to shaping my perspectives on what is relevant and also my abilities to pursue the underlying scientific challenges. My Postdoc supervisor, mentor and friend Professor Rüdiger Rackwitz from the Technical University of Munich was clearly the single most important of those but many other researchers from especially the Joint Committee on Structural Safety (JCSS) played a big role for me – and the course of my career.

The research field of structural reliability emerged from the ambition to establish a rationale for designing structures such that they are both safe and economically efficient.

In the early days, in the period between 1950-1980, the challenges associated with this ambition were predominantly of theoretical and technical characters and much of the focus in the research community was devoted on the very specifics of probabilistic modelling and analysis. However, alongside these developments slowly and steadily a new basis emerged

> ATUALMENTE, ACERCA DE NOSSAS PRÁTICAS NA INDÚSTRIA GLOBAL DA CONSTRUÇÃO, ESTAMOS CONSUMINDO ALÉM DO NECESSÁRIO EM TERMOS DE MATERIAIS E RECURSOS — E DE EMISSÕES DE CO_2

and matured for representing knowledge in general and for supporting rational decision making in the face of uncertainty and lack of knowledge. A basis that is general and in fact applies for any type of decision-making context in society whether that be related to the safety of structures, management of risks due to natural hazards, reliability performance of infrastructure systems or safeguarding the qualities of the environment – sustainability.

I was among the researchers that picked up on the possibilities this new basis for supporting decision making offers for supporting societal developments in the face of contemporary challenges related to resilience and sustainability. But to go in that direction necessitated that I had to look at systems in a more abstract and general manner than traditionally pursued in structural engineering – to capture the complex interactions between society at broad and the technology society is depending on. This "redirection" of my original research focus has been extremely challenging and interesting - and over time involved me in developing strategic, operational and tactical decision support in the context of e.g. the World Economic Forum and the OECD High Level Risk Forum.

IBRACON In your presentation at the 63rd Brazilian Concrete Congress, you said that we humans know what to do to achieve sustainability in the built environment. What do we need to do as engineers and society, and how much time do we have?

| **MICHAEL HAVBRO FABER** | I do appreciate that this appears to be a blunt statement – but it is nevertheless correct. The 80%-20% principle applies also here – meaning that 80% of the challenge may be solved with 20% of the efforts.

Presently – with our practices in the global construction industry – we are overspending with respect to materials and energy - CO_2 emissions. But our practices are also associated with other important impositions to the qualities of the environment that we rely on as a global society. Important bottlenecks in present practices as well as possible solutions are collected in the Globe Consensus on Sustainability in the Built Environment, and here I can only touch upon some of these.

In essence the damages we cause relate to the present organization of the construction sector and the inadequate use of existing knowledge, rather than missing knowledge. Now that I mention that I also have to highlight that in my opinion academics now should focus on getting the existing knowledge in action in industry rather than use the challenge of the green transition as an alibi for financing new research in their respective fields.

There are many facets related to this issue question but what essentially is needed is a paradigm shift in construction where both the organization and the approach is redesigned. The leading objective should be that construction must serve society - and not particular stakeholders of the construction industry.

The organization of the sector should respect that construction necessitates consumption of resources (capacity of the earth system to sustain CO_2 emissions) that are shared by the global community (Fig. 1). This in turn necessitates global coordination and consensus on how much, where and how the global society wants to construct. This coordination is a matter of equity on human rights across the citizens of the global community. To achieve this necessitates coordinated political action at global scale – which unfortunately seems to be rather difficult to imagine at present – but nevertheless will be required.

In addition, all processes in the construction industry should to the highest extent be regulated based on their performance – rather than prescriptions. In addition to traditionally considered performances, we now also need to include new ones – such as CO_2 emissions relative to the benefit provided by the structures we build. To achieve this in the best manner we need to revisit design theory – matter-form-function – where we shift from the present practice that material developers dictate the "matter" and engineers do their best to find "forms" that serve the "function" to a practice where "function" and possibilities for "form" to a much higher extent dictate the performance of "matter" and ultimately what the material producers shall deliver. This redesign I believe the professionals in construction can and should take initiative to conduct themselves, through the normal processes of establishing and revising Standards

and codes. The premise here is that we have a limited budget for CO_2 emissions. When we decide on how much CO_2 should be allocated to construction e.g. at national scale, then we need a paradigm for deciding which types of structures give society the most value (welfare) and how this value compares with the values society could achieve by using the budget of CO_2 emissions for activities in other sectors. This may or may not reduce CO_2 emissions from construction but it will ensure that what we construct has the highest possible relevance for developing welfare and the highest possible (CO_2) efficiency in providing this. However, political support is needed to ensure that these redesigned codes and Standards are globally invoked.

On top of this we need a global regulation of the construction industry that ensures equal terms for tendering and provision of products and services. We must ensure that the development of construction and the competition in construction – globally – take basis in equal terms with respect to the performances. The construction sector is international. Major consulting companies and contractors operate in the whole world. For such actors it is not possible both to be setting new standards for reducing CO_2 emissions and at the same time to be competitive in a market where other actors maintain their focus on economic competitiveness. There must be established a mechanism that both provides maximum CO_2 emissions reductions and fair competitiveness. The free market cannot achieve this without substantial support from globally implemented common regulations of the sector. I would think that such a regulation might be realized in the same manner that FIDIC (Internacional Federation of Consulting Engineers) presently regulates construction with respect to contractual issues. Political support will be needed to ensure that such a regulation is invoked globally.

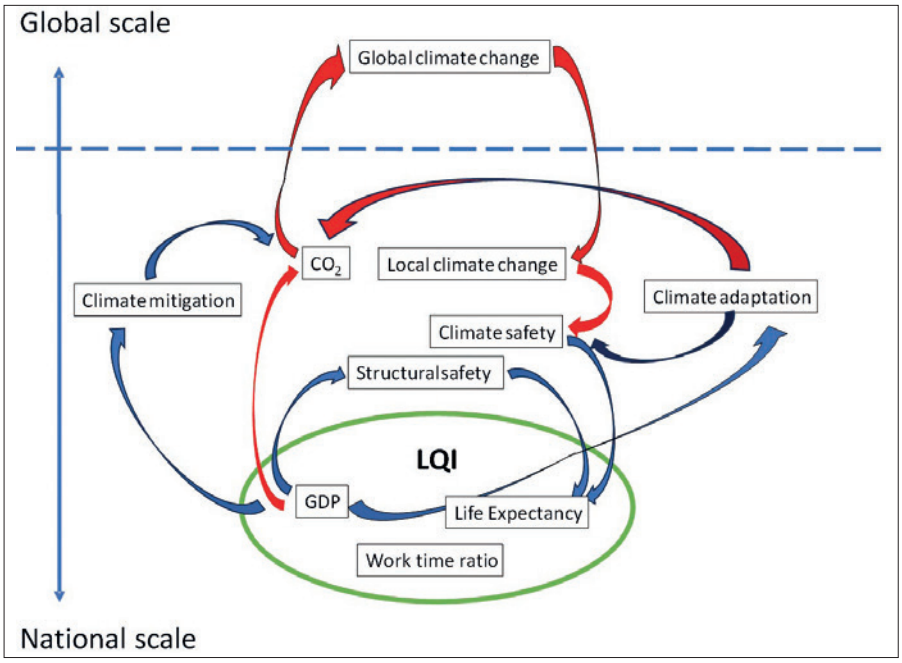


Figure 1 - Tradeoffs between welfare, resilience and sustainability: illustrates the how decisions in society at national scale aiming to improve welfare (Life Quality Index) depend on an optimal tradeoff between life expectancy at birth and economic capacity (GDP). Moreover it is illustrated how economy is related to CO emissions, and how these have a back coupling on life expectancy. Finally it is indicated how economy may be used for mitigation and adaptation that again have back coupling to CO_2 emissions.
Font: Min Liu, Dagang Lu and Michael Havbro Faber

In the daily practice however, there are many small but important things that all professionals in construction can do to improve the situation. We should all – with our personal integrity and professional insights – direct our focus not only on ensuring cost efficiency and safety – but on how to reduce waste of material, waste of energy, overdesign and use of materials that are overperforming relative to requirements, but also take benefit from a more holistic joint consideration of design and integrity management during operations, and the use of advanced analysis methods both in design and reassessments where it has potentials for reducing emissions; this is very much the case especially when dealing with design of extraordinary structures and when reassessing existing structures – e.g. in the

> É PRECISO QUE SE ESTABELEÇA UM MECANISMO QUE GARANTA A MÁXIMA REDUÇÃO DAS EMISSÕES DE CO_2 E UMA JUSTA COMPETITIVIDADE

> EM PRINCÍPIO, COM RESPEITO ÀS 'FRONTEIRAS PLANETÁRIAS', ESTAMOS LIDANDO COM UM ORÇAMENTO LIMITADO, SENDO QUE A SOMA DOS DANOS ORIGINADOS DE TODAS AS NOSSAS ATIVIDADES PRECISA SE MANTER NO LIMITE DAS CAPACIDADES DE REPOSIÇÃO DO SISTEMA TERRESTRE

context of service life extensions.
It will take a big effort of the construction industry to make this transition – but it is needed – urgently. Natural scientists have been pointing to the gravity of the situation for decades – and very little has been accomplished so far. Indeed, on many accounts the situation is getting worse. It appears that the global temperature already within the present decade will reach levels that were hoped not to occur until mid-century - or even later. The local effects of global temperature rise are now so severe around the earth that we all are exposed to some of them. However, what is important to understand is that some of the regularities that have been governing the climate till the present, may change and even disappear – we may reach and go beyond the so-called tipping points for the relatively stable climate conditions we have profited from in the past. As an example, one of these tipping points concern the AMOC current (Atlantic Meridional Overturning Circulation)[1] in the Atlantic Ocean. At present natural scientists are pointing at a possible collapse of this current already mid-century. Consequences of such a collapse are estimated to include a total change of the climate in northern Europe – with conditions becoming similar with those we presently find in the high arctic regions of e.g. Greenland, Canada and Russia. Livelihoods as we know them presently in countries such as Denmark, Norway and parts of the UK would disappear.
There is no doubt that we are in a severe lack of time – we need to act now – and ideally – to avoid passing climate tipping points we need to implement substantial changes in the way we do things already within time horizons in the order of a few years.

IBRACON I WAS IMPRESSED BY THE NUMBERS YOU SHOWED IN THAT CONGRESS: NOWADAYS, THE CONSTRUCTION SECTOR IS RESPONSIBLE FOR 20% OF GLOBAL CO_2 EMISSIONS, 90% OF GLOBAL MATERIAL CONSUMPTION, AND 50% OF GLOBAL ENERGY CONSUMPTION. AND FUTURE TRENDS INDICATE ACCELERATED GROWTH DUE TO GLOBAL POPULATION INCREASE AND

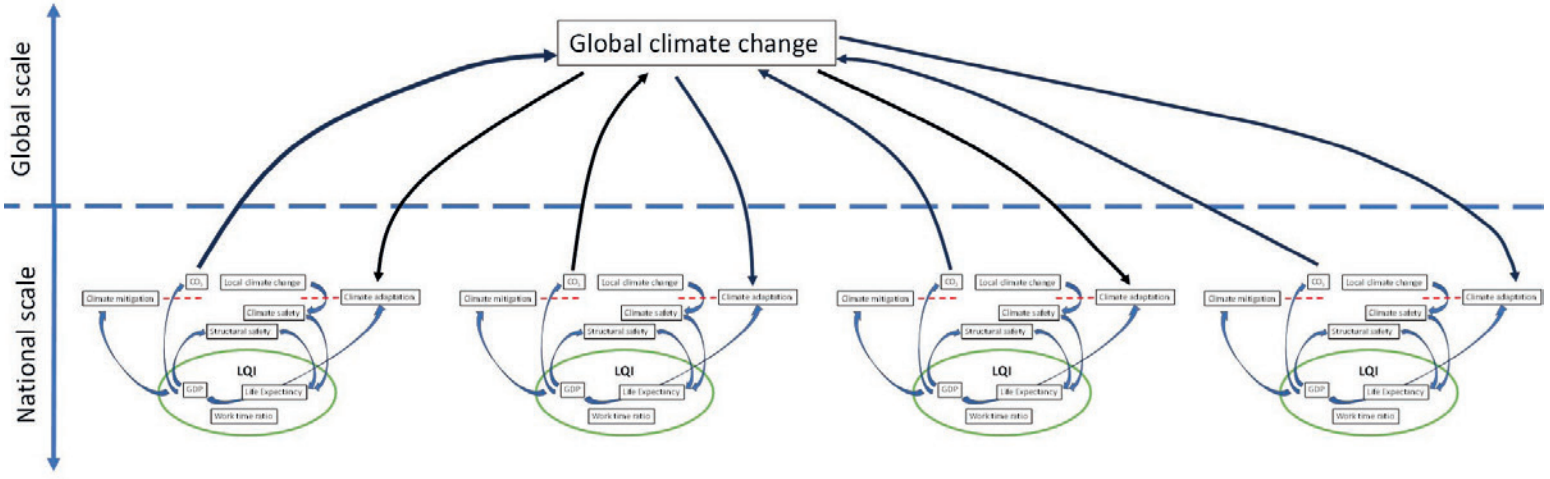


Figure 2 - CO_2 budgets for all nation states must be agreed at global level: we have to decide on a global budget for CO_2 and how to distribute this between nation states. When we do this there is a strong ethical implication to ensure equity in terms of possibilities for welfare and rights to safety. This implies that we must account for the differences between nation states with respect to demands for construction due to population growth/urbanization, the needs for adaptation to ensure safety and possibility for economic growth and also to which degree the different nation states are exposed to the effects of climate change – caused in many cases by other and more rich nation states
Font: Faber

[1] AMOC IS A SYSTEM OF OCEAN CURRENTS THAT CIRCULATES WATER WITHIN THE ATLANTIC OCEAN, BRINGING WARM WATER NORTH AND COLD WATER SOUTH

CONSTRUCTION DEMAND IN DEVELOPING COUNTRIES. WHAT ARE THE POSSIBLE SOLUTIONS TO REDUCE CONSUMPTION AND EMISSIONS TO SUSTAINABLE LIMITS?

| **MICHAEL HAVBRO FABER** | On a global scale – as already indicated – we need coordinated actions – at political level and professional level. But the construction industry does not stand alone – and other sectors are also very important. In principle with respect to Planetary Boundaries we are dealing with a limited budget problem where the sum of the damages originating from all our activities must add up to effects that are safely within the capacities of the Earth system. Across all our activities as a global community we thus must decide – at least until game changing technologies such as carbon capture can and will be sufficiently upscaled – how we best use these shared budgets; of course with due respect of equity (Fig. 2). We must decide how much of our shared budgets should be allocated for provision of the essentials, like shelter and food and health and how much we allocate for the non-essentials, like fashion clothes and other lifestyle and amusement products. This could e.g. imply that more emissions from construction should be tolerated in developing countries, such as on the African continent, in South America and Asia, where a major increase in population is expected within the next few decades (alone in Africa around 1 billion towards 2050). To compensate for these added emissions, it could be a consequence that construction in more developed parts of the world with stable or declining populations are set on pause or at least limited to construction for climate adaptation for a substantial period of time.

I appreciate that this may seem an illusional perspective with the present political situation of the global community – dominated by divergence, rapidly increasing conflicts and trade wars. However, unless we can achieve a global consensus for the required actions to reduce our environmental foot-print at large, for the better of the most – the reality we are facing in the global community could be rather dire. This especially I am afraid will concern developing economies, and the parts of the world that will be most severely affected by the effects of climate change.

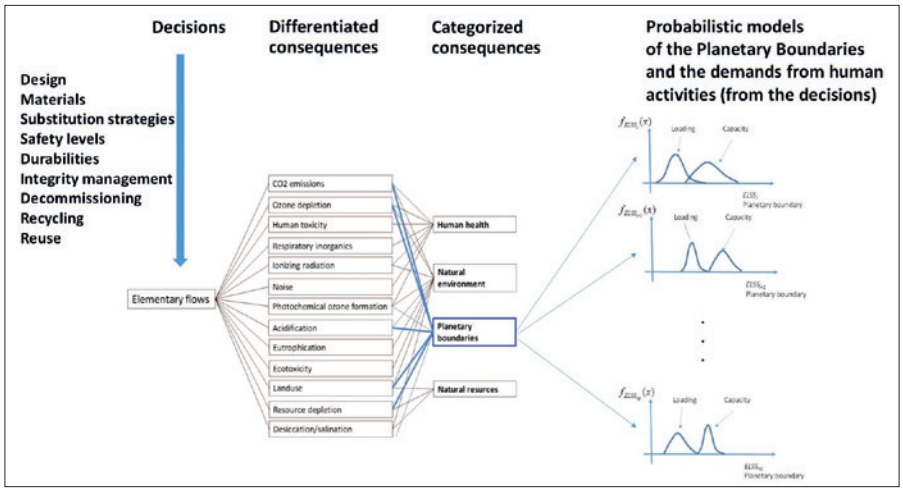


Figure 3 - Model that relates decisions on the design and use of different types of cementitious materials – over LCA – to their impositions on the Planetary Boundary.
Font: Faber

IBRACON HOW CAN IT BE PROVEN THAT THESE TECHNOLOGICAL SOLUTIONS ARE SUFFICIENT TO BRING THE BUILT ENVIRONMENT TO NET-ZERO CO_2 EMISSIONS BY THE MIDDLE OF THE CENTURY?

| **MICHAEL HAVBRO FABER** | Unfortunately, only time can prove the future effect and success of the decisions we make and the actions that we take today. The best we can do is to take the situation serious and carefully make a strategy on how to address the tactical crisis we are in the middle of. Such a strategy has to be devised so that the outcome of the strategy is sufficiently robust with respect to the different scenarios that we can imagine for the further development of the global community, including crisis, trade wars and the very little understood global and local impacts of the climate changes that cannot be avoided.

IBRACON ARE THERE PROBABILISTIC MODELS CAPABLE OF CORRELATING THE

> SOMOS RACIONALMENTE CAPAZES HOJE DE AJUSTAR OS REQUERIMENTOS NORMATIVOS ATUAIS PARA A CONFIABILIDADE ESTRUTURAL, DE FORMA COERENTE COM AS PREFERÊNCIAS SOCIAIS QUANTO À MORTALIDADE CLIMÁTICA

> PRECISAMOS DE UMA NOVA ABORDAGEM DO PROJETO ESTRUTURAL, NA QUAL AS INCERTEZAS SÃO LEVADAS EM CONSIDERAÇÃO POR MEIO DE DECISÕES ROBUSTAS QUANTO AOS RESULTADOS DE MUDANÇAS CLIMÁTICAS LOCAIS

ENVIRONMENTAL IMPACTS OF LIFE CYCLE ASSESSMENT FOR CEMENTITIOUS PRODUCTS AND CONCRETE STRUCTURES TO PLANETARY BOUNDARIES? WHAT ARE THE SCENARIOS?

| **MICHAEL HAVBRO FABER** | Yes, we do have the basic formulations – actually since around a decade – and we are presently establishing first models that facilitate not only that we can relate decisions on the design and use of different types of cementitious materials – over LCA – to their impositions on the Planetary Boundary related to CO_2 emissions (Fig. 3). But not only that, presently with the recent information from other researchers relating to the assessment of climate mortality we can relate the consumption of different materials to global temperature change and associated loss of future lives caused by different local climate change effects, such as flood event or simply just increased temperatures. With this information we now have rough estimates on what we should – as a global community - invest into avoiding emissions of e.g. 1T of CO_2, namely in the order of 300$US. This amount is not far from the numbers being suggested as CO_2 taxes. To introduce such a requirement in construction rather than a CO_2 tax has the benefit that it puts focus on actions that change present practices directly in the construction industry – and maintain equal terms for competition. A further important aspect associated with these new developments is that we can also assess the tradeoff between the benefit of material consumption in terms of life saving through increased structural safety, and the disbenefit of material consumption in terms of the associated climate mortality. With this we are now able to rationally adjust (reduce) present requirements to target reliabilities for structural design – in coherence with societal preferences for life safety investments accounting for climate mortality. It is in fact ethically very debatable not to do so.

IBRACON BESIDES CONSTRUCTION DEMATERIALIZATION, WE NEED TO BUILD SMART AND RESILIENT CONSTRUCTIONS TO MITIGATE THE CONSEQUENCES OF CLIMATE CHANGE. HOW CAN WE ACHIEVE THIS?

| **MICHAEL HAVBRO FABER** | This is good point and a very pressing issue. The challenge here is that we are facing a new situation where the main uncertainties we are dealing with in the phase of structural design are due to lack of knowledge – i.e. epistemic uncertainties. The models for global temperature rise are in themselves subject to substantial epistemic uncertainty. In addition, we know very little about the more exact local – downscaled – effects of global climate change. This means that we need a new approach for the basis for structural design where these uncertainties are addressed by consideration of the robustness of design decisions with respect to the outcome of the local climate changes. We know how to do that from a methodical point of view, but the insights are still far from being realized and applied in practice. We are presently doing what we can to disseminate our findings.

IBRACON WHAT IS THE GLOBAL CONSENSUS WHOSE JOINT COMMITTEE YOU WERE PRESIDENT OF? WHAT IS THE CONSENSUS SUPPORTED BY 5,000 PROFESSIONALS FROM 150 COUNTRIES AFFILIATED WITH SIX ORGANIZATIONS?

| **MICHAEL HAVBRO FABER** | The Globe Consensus – actually the Globe Consensus on Sustainable Developments in the Built Environment took basis in a workshop conducted at Tongji University in 2019. At this workshop professionals and scholars predominantly from China, Taiwan and Europe discussed the issues of sustainability in construction – and the result of this became the Tongji Consensus. After the workshop the Joint Committee on Structural Safety decided to support the Tongji Consensus and the idea emerged to seek the support of the Tongji Consensus also from the side of the Liaison Committee - comprised by the six associations IABSE (International Association for Bridge and Structural Engineering), CIB (International Council for Research and Innovation in Building and Construction), IASS (International Association for Shell and Spatial Structures), ECCS (European Convention for Constructional Steelwork), Rilem (Reunion Internationale des Laboratoires et Experts des Materiaux) and fib (International Federation for Structural Concrete). This was successful and in 2021 a new Joint Committee on the Globe Consensus (JCGC) was initiated under the Liaison Committee – in a

similar structure as the Joint Committee on Structural Safety. With the support of the Associations of the Liaison Committee the task of the Joint Committee on the Globe Consensus is to help push for the necessary changes in the construction industry – by means of the aggregated knowledge of its member Associations and their global networks.

IBRACON How is the Global Consensus spreading? How can its impact be measured?
| **MICHAEL HAVBRO FABER** | On the positive side we have managed to enlarge our support basis – and also to disseminate our objectives at different levels in society and within our profession. Since we started, we have achieved the engagement of e.g. IBRACON, Alconpat and PREVECII and we are coordinating and collaborating now also with the UN supported organization Global ABC[2]. Contacts for further exploration of collaborations with ACI have also been accomplished. In parallel an important activity has been initiated to benchmark CO_2 in building construction – both in Europe and in Brazil. Earlier this year we also had an important meeting at Tongji University in China to engage Chinese authorities and professionals in the construction industry in benchmark studies relevant for Chinese construction practices.
Now – for a period of 5 years since the first initiative (Tongji Consensus) or 3 years since the formal initiation of the JCGC – in a situation of urgency – I must admit that I am not happy at all with the impact and speed of activities. The challenge I see that the JCGC is facing is very similar to the challenge we are attempting to solve with the JCGC – namely an organizational one. The JCGC is not organized – I could not find support for that among the Associations – as an organization that can engage and support the global professional community in construction. It is being considered and also operated as a new Association – or committee – along the modes of operation of in principle any of the supporting Associations. This implies long process for decision making, long intervals between meetings as people are already very busy with other activities, and also a tendency to strive for consistency between activities of the JCGC and the Liaison Committee member Associations. Frankly stated – there is no sense of urgency and with the present working mode I am afraid that even though good people are involved and important work is ongoing – it will not have the required impact to mitigate climate changes in due time. This in turn could very well lead to a situation where instead of attempting mitigation of climate change the profession will have to focus on adaptation to climate changes.
The global community – as well as the construction sector fails to appreciate that we are presently in a tactical decision situation – and that we need to reorganize and act accordingly. When a person is about to drown the by standers do not start out with having a meeting to debate who is the best suited person to provide help and to discuss what is the most appropriate suit to wear – in tactical situations immediate action is necessary as a first – and if the course of action turns out not to be perfect then you try to adapt along the way.

IBRACON What is the collaboration between Global Consensus and IBRACON since a protocol of intention was signed by the entities in 2022?
| **MICHAEL HAVBRO FABER** | From our meetings in the JCGC I am aware that IBRACON has initiated several activities in Brazil – including the mentioned benchmark study of CO_2 in housing construction and lately also the organization of a summer school on structural safety and sustainability to be conducted in 2025. I am sure much more is going on – but I do not know the details of that.

IBRACON What are your hobbies?
| **MICHAEL HAVBRO FABER** | I am not entirely sure that I have a hobby in the normal sense – however I am engaged in many activities that I enjoy. Throughout my life I have had the fortune to love my work to the full extent. I also love to spend in the outdoors, hiking, fishing, hunting and diving. Exercise I mostly get from work on my farm in the forest and vegetable garden – and from jogging. Finally – the most important daily component of my life is my family my wife Linda and my son Jasper.

[2] The **GlobalABC** is a multi-stakeholder alliance committed to delivering a zero-emission, efficient and resilient buildings and construction sector

> A COMUNIDADE GLOBAL — COMO O SETOR DA CONSTRUÇÃO — TEM FALHADO EM CONSIDERAR QUE ESTAMOS NUMA SITUAÇÃO DE DECISÃO TÁTICA, QUE REQUER AÇÃO IMEDIATA, QUE VAI SENDO CORRIGIDA NO CURSO DA PRÓPRIA AÇÃO