

W086 - Building Pathology

Trend Report

Joint Coordinators Sergio Croce and Peter Trotman, in cooperation with Technical Secretary Enrico De Angelis, have put W086 past, present and future under the microscope with this Trend Report.

The result is an analytical study whose contents are of interest to a far wider circle than the W086 Membership.

Not the least significant is the authors' reasoned account of why Building Pathology impacts on each and every operator engaged in the building process.

Introduction and Background

W086 is essentially concerned with learning from the past and the knowledge we can derive from building failures and their treatment. Its basic work as a CIB Commission has always been to provide an open forum to debate the results of the analysis of case studies and to set up tools and methodologies to be applied in their diagnosis.

Building Pathology's (BP) basic aim is to understand the degradation processes, to define methods and tools in order to easily identify potential defects (at a first design stage, as well as in service actual ones) and to devise solutions to reduce their effects and to avoid any unforeseen cost for repair or maintenance.

BP is therefore of interest all over the world, both because it is associated with a basic human need, that is the need for a comfortable shelter that lasts in time, and because, as it has been clearly demonstrated, premature failures cause an enormous waste of resources. The life cycle cost of buildings, as a matter of fact, exercises a major weighting over gross world product:

- Building activities represent approximately 40% of the world production
- Solid waste production from building construction, demolition and the production of building products approximately represents 40% of the world solid waste production

Moreover, building failures generate approximately 10% of that life cycle cost. Then, failure prevention could very substantially affect both the direct costs of a building and the environmental impact of the construction sector, in every country. Over a period, the dissemination of BP experience provides a fundamental chance to enhance the design for durability and maintainability of buildings and building products.

Relevant to All in Building Process

Besides legal consultants, who are obviously interested in diagnostic tools and methods, every operator involved in the building process is potentially interested in BP and its fallout.

For example:

1. Building designers are the very first who need the dissemination of BP derived experience
2. The construction industry, as each contractor often assumes the responsibility for assuring the service life of their product
3. The building product industry, to take proper care of the possible decay actions and to reduce the risk of anticipated failures

4. Inspection bodies, who need BP tools and experience to operate efficiently and to prevent building failures
5. Real estate managers who have to pay if errors or omissions are committed and must be able to weigh up failure risks against prevention costs
6. Insurance agencies, because BP experience and data constitutes the basis for any serious assessment of technical risk and its management.

Current State of Art

CIB Publication 155 Building Pathology, A state of the art report is still the most up to date reference. This Publication standardises a basic terminology, introduces the basic concepts in defect and failure investigation and treatment and develops the following themes:

- Investigation methodologies (diagnostic process)
- Diagnostic aids and tools
- Cost related to building defects
- Collection and use of data coming from cases of failures
- Risk analysis and risk management

As concerns basic concepts and investigation methodologies (as risk analysis, for example), we can state that no more innovations are to be expected either from W086 or from Building Pathology in general.

As concerns diagnostic aids and tools, we can distinguish measuring instruments from diagnostic support software. In the first case, nowadays, the market offers a host of meter systems and sensors. Moreover, the innovative trend in electronics has made these tools mostly affordable. We have, now, many small portable meters and probes, capable of assessing the conditions of different materials and environments; after many years, then, data recording and storage is no more a problem, as easy and cheap systems exist.

The next boundary to be overcome is the development of low cost sensors to be integrated into building structures and to be able to monitor, continuously or when needed, critical decay processes and failure mode advancements.

However certain additional clarification is needed. More instruments at a lower price do not immediately mean that they are easily available to anyone: as everybody knows, any instrument requires continuous checking and calibration, in order to assure the reproducibility of its measurements; moreover, it needs trained people to use it, to be able to understand the acceptability of measuring conditions, to record the results and to perform the necessary maintenance. Then, the measuring activity must be correctly planned and defined to avoid the waste of resources caused by an improper choice of meters and probes, or data collection method. Eventually, although instrumentation is increasingly available and cheap, the need for more and more precise and detailed data makes diagnosis a more precise but still expensive activity.

As concerns diagnostic support software, these tools are not so well diffused, available and efficient as practitioners would like. It is difficult to synthesise human analytical capability just as the human eye, ear and hand cannot be easily substituted by machines and meters. Building failure diagnosis practice, in fact, can be easily translated in a procedural form only at a general level.

Artificial Intelligence proposes neural network tools to treat complexity; its applications have yielded good results in everything pertaining to visual recognition and it is not difficult to forecast possible applications in the analysis of defects and anomalies. The basic problem lies in the fact that the training costs needed to make neural networks able to recognise the many kinds of building failures and of building elements, parts and details that can be subject to them is still not worthwhile.

The collection of data derived from cases of failures, i.e. what can happen to a specific building part, subjected to specific degradation factors, has been practised, in many countries.

Nevertheless, this practice is not very well harmonised and it is usually connected with non-continuous activities like the publication of the results originating from either private or public funded research activities. This is, of course, quite natural, as the various publications have different aims and contents. Anyway, an universal building failure database does not exist.

Cost related to building defects is a very important topic, as it is the only way to understand just how important it is to prevent failure and to activate preventive actions and politics. Nevertheless, a continuous survey of the situation is usually never done, except in few cases.

Despite the fact that every country is potentially interested in BP, there are many differences among the approaches practised. The level of economic development, for example, influences the amount of available resources which can be invested in BP application and related research. Thus, few countries have established agencies or other institutions specifically devoted to BP and the dissemination of information coming on the experience of building failure and their treatment.

In conclusion, national investment in BP does not seem to have all over the world a strong correlation to the need for prevention of cases of failure; but this is no more than a feeling because data, available from the few countries who invest in BP and building industry related research are not structured and up to date enough to support a systematic analysis of prevention costs and saving.

Trends and Future Perspectives

- The need: data collection and communication enhancement

We have stated above that W086 basic work has always been to be an open forum to debate the results of the analysis of case studies.

This can be considered as the basic task for W086 as, we think, we will always have the opportunity to perform the analysis of new cases of failure and to apply BP methodologies and diagnostic tools: new cases, in fact, are generated daily and new failures have to be interpreted and resolved and, potentially, there will always be the need to open a discussion about it and, if necessary, to tune up methodologies in order to include their treatment.

These "new problems" are those necessarily generated by the application of new products, or the application of old products in new conditions, and by the "contamination" of traditional practice and new technologies or those imported from other industrial sectors.

Although the theoretical basis for BP seems to be well defined and understood, its practice and, mostly, what we could call "building failures derived know-how", are not widely diffused.

In conclusion, few issues stand out clearly:

- there is a lack of data about building degradation processes and a global absence of data about frequencies and geographical distributions of pathological failure modes
- this data is useful to define pathological failure prevention strategies in building and to monitor their success
- currently available data about building degradation processes are not sufficiently disseminated, that is, in the most advanced countries also, the standard practitioner or constructor always seems to ignore (or to have forgotten) something that could have helped him to avoid a pathological building failure

- What Causes the Lack of Data Collection

There are many factors that influence the availability of data. It may be noted that building failure cases

are frequently connected with quarrels among owners, designers, contractors and producers and, as people naturally do not like making a laughing-stock of themselves, the desire for privacy makes data diffusion a delicate job and makes those involved in data collection somewhat wary of contributing information.

Then, the collection of data about frequencies and geographical distributions of pathological failure modes is a difficult and expensive job. It is expensive because data is spread all over the world and among a lot of different people (the property managers of every building), so that data collection requires people to recognise its importance and to spend time on it. Moreover, it is not easy because the data comes from different failure cases and is not easily classified. Differences in building products and technologies, as well as differences in climatic conditions and their exposure to degradation factors, give rise to different problems and different cases of failure. Eventually, building owners and facility managers have different service life expectations in different countries and the perception of a failure as pathological failure differs from case to case.

- What Causes the Absence of Communication about Data

The collection of data about basic building failure modes and degradation processes, i.e. what can happen to a specific building part, subjected to specific degradation factors, is not a difficult or expensive activity. As mentioned before, there are many examples of publications about occurrences and their avoidance and remedies.

These data collections anyway appear to be ineffective in the improvement of failure prevention. Many failure cases, in fact, are clearly the same as (or very similar to) what has happened in other situations and have been already analysed. Of course, publications will never eliminate building failures and errors nor their persistence.

Building pathologists have mostly spent their organisations' resources on technical questions in order to solve practical and actual problems and few of them on the definition and implementation of defect prevention strategies and general policies.

Few of them, although involved in teaching activities, have been able to initiate strong actions in the communication of BP results and fewer have worked on communication strategies, in order to optimise communication efficiency and to maximise its results.

- W086 Roles and Priorities

W086 is not the only CIB Group working on topics related to building failures and their treatment. A clear definition of its role and the boundaries of its scope is needed, in order to reduce waste of resources, to improve communication among researchers and, eventually, to improve research efficacy.

- W080 - Prediction of Service Life of Building Materials and Components, together with RILEM 140 TSL, works on failure modes in order to define general and specific methods to predict maintenance frequencies for in service building products and components. Its current work programme is linked to ISO/TC59/SC14 "design life of buildings" and it is structured in five separate Working Groups:
 1. Information Technology in Construction that aims to develop tools for gaining ready access to service life and durability information from which existing knowledge can be retrieved and new knowledge developed.
 2. Service Life and Durability that works on the simple Factorial Methods and their application for estimating service life of materials and components and reviews instances in which it can be successfully applied.
 3. Selection of Service Life Prediction Methods, that works on the development of Reliability and Probabilistic Methods in the evaluation of service life of building materials and components.

4. Understanding Factors causing Degradation, that aims to develop Damage Functions and Environmental Characterisation to be used in the degradation models that incorporates known degradation mechanisms.
5. Consequences for Buildings of Climatic Variability and Climate Change
 - o W094 - Design for Durability is a more recent CIB Commission that faces W080 Themes from the point of view of the design and attempts to develop internationally accepted design methodologies to make it easy and natural to include durability in the design process. Its current work programme (executed in conjunction with an ISO Working Group (ISO/TC 59/SC3/WGG4) "Design Life of Buildings") is to devise internationally accepted information systems which can assist designers concerned with durability planning of buildings.
 - o W070 - Management, Maintenance and Modernisation of Building Facilities is a CIB Commission of long standing that has recently been renamed and which has redefined its aims to make them more general and broader, so as to exchange knowledge and to promote understanding of the sociological, managerial, economic and technical requirements of maintenance and modernisation and to stimulate the development of structured Maintenance Management Information Systems (providing feedback toward design).

Amongst these three Commissions, the principal characteristic of W086 seems mainly to operate, as we said earlier, as an open forum in which to debate the results of the analysis of case studies and to set up tools and methodologies to be applied in their diagnosis.

Its links with the other Commissions listed are clear. Case studies provide the basic information needed to identify those most frequent failure modes of building components against which to evaluate a service life (W080), as well as service life prediction data to help pathologists to perform a quantitative analysis. Moreover, diagnostic techniques developed in the failure analysis are the same that can be used in the durability conscious design of building, building components and products (W094) to prevent pathologies and reduce the risk of premature failures. Eventually a Maintenance Management Information System (W070) is the final user of data collected by pathologists, designers and building material experts.

The foregoing makes it clear that the roles and priorities of W086 can no longer be developed in isolation. The complexity of the actual building process, together with the resource shortage that nowadays afflicts every research sector, require actions to be planned and performed jointly, in order to optimise results. Moreover, these joint efforts and actions cannot anymore be developed at a national level and CIB seems to be the natural umbrella under which to perform these actions and to disseminate the results.

Following the Vancouver Meeting, a considerable amount of thought about the needs and chances of the worldwide building sector and the results of the recent CONPAT Meeting in Montevideo, Uruguay where some W086 members had the opportunity to confront the South America state of the art and conditions, we are of the strong opinion that those joint efforts are needed and some joint actions must be planned together, inside CIB institutions.

- A General Framework for the Development of W086 Actions

We think that W086 actions should be developed within the framework of a common project and we propose to develop together actions aimed to attain the following three objectives. The first two objectives basically require technical actions in order to:

- o define a world-wide strategy in data collection relating to building failures, their frequencies and costs
- o stimulate an improvement in communication efficiency and efficacy both about problems and tools and methods necessary to resolve them

Every Commission talks about communication, information systems and the provision of knowledge, so

no further explanations are needed.

The third objective to be reached requires, on the contrary, a political action that we think is essential to support the development of the other two: to make everybody concerned with the building process aware, that it is not only the designer, contractors and producers of building products, but also their clients, that are the users who pay for building failures and non quality, and, most importantly, governments, who are the only ones who can support long term actions needed to reach the two above objectives.

In other words, we believe that a political initiative is necessary in order not only to identify the required resources to support research, but also to establish those regulatory tools that are fundamental to attain those two goals, promote building care and make building failure prevention effective and efficient.

In Europe, for instance, a common policy in building failure cost reduction does not exist. Of course, as everybody knows, these are not arguments faced by The Treaty of Rome and the European Union since the Member States have not given European Parliament any mandate to define any building regulation except those requirements needed to allow construction products circulate among Members' market.

Some studies have already been developed, for example, to find a way to harmonise the level of safeguard of European citizens about their properties. Sustainability questions and the Kyoto Protocol could be the motive power for a new systematic approach, and Europe could be too small a context within which to develop something really worthwhile. Again, CIB Commissions, mostly frequented by researchers and academic people, together and ISO Working Groups⁵, where more frequently Governmental Agencies sit, should be the appropriate places to initiate a promotion of these themes and to find the support to go on with technical ones.

- W086 Short Term Actions

The first short term action that the CIB BP Commission is going to activate, then, is to promote a brief reflection about this general framework and the planning of joint action together with every other interested Commission. This is to set in motion the first action which we think is to be activated, i.e. the political one.

What W086 wants to start by itself, which is within the accepted boundaries of its scope and role, is to develop one of the possible actions of communication improvement, as it has been stated at the Vancouver Meeting.

In the Internet era, it is easy to think that any communication improvement is based naturally on the most efficient world wide web. Thus, a short term action can be to develop an experimental www.buildingpathology site, for commencing the collection of some of the information related to building failures and their diagnosis.

The basic idea is to make W086 something more than a set of members participating in a set of events (the meetings) and activate a continuous members' activity in the world wide web.

A "forum in which to debate the results of the analysis of building failure case studies and to set up methodologies to be applied in their diagnosis" can be easily transferred in internet pages and through these pages a continuous activity could be easily established.

The Coordinators of W086 will soon be sending every member the basic functions and rules of this BP Forum with the aim of catalysing a discussion about it and developing the www.buildingpathology site to be presented at the next meeting in Lisbon, June 2000.

- W086 medium and long term actions

The first two short term actions to be developed should be regarded as in the nature of fertilising actions

aimed at enforcing connections among Commissions and at enhancing the profile of W086 among not only research institutions.

Looking to the longer term, the political action should be activated and enforced, in order to obtain audience and resources to activate what is mainly a cultural action: a data collection that can turn in a knowledge base able to support design for durability and service life prediction, through which to promote building care and make building failure prevention effective and efficient.

