The first year of activities of the “Observatory Claudio Ceccoli”, on the defects of the building structures

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Summary

A research centre entitled “Observatory Claudio Ceccoli” focused on Forensic Engineer has been established on January 2012 within the Department of Civil, Environmental and Materials Engineering (DICAM) of the Faculty of Engineering, University of Bologna. It represents one of the few Italian research centres which is entirely devoted in Forensic Engineer-related issues. The activities of the centre involve the interaction of several “actors” such as the academia, practical engineers, architects, construction companies, lawyers, insurers.

The main scientific objective of the centre is to promote research on the building defects through a systematic study of real cases as available from the Court of Bologna. The main practical objective is the development of a web-based database collecting all the juridical cases available from the Court of Bologna involving defects on building structures.

The present paper illustrates the aims of the centre and presents some results from the first year of activities.

Keywords: Forensic Engineer, building defects.

1. Introduction

Forensic engineering, according to the National Academy of Forensic Engineers (NAFE), is "the application of the art and science of engineering in matters which are in, or may possibly relate to, the jurisprudence system, inclusive of alternative dispute resolution." Forensic engineers investigate and reconstruct failures in a variety of systems, often determining the cause and liability of an event as it moves toward, or into, a courtroom setting.

Forensic engineering, which draws on many different disciplines, is of relatively recent origin as a subject in its own right. The National Academy of Forensic Engineer (NAFE [1]) was formed in 1982 in New York to advance the skill of engineers who serve as engineering consultants to the parts involved in the litigations as expert witnesses in courts, arbitration proceedings. Its aim is to educate professional engineers practicing forensic engineering and promote high standards of professional ethics and excellence of practice. In Italy the development of the practice of the forensic engineer as an own field is more limited, since the establishment of the National Association of Forensic (AIF [2]) Engineer is very recent (2009). The institution of the AIF has been preceded by the master program in forensic engineer, established in Naples by Nicola Augenti (current director) on August 6, 2008, which covers a broad spectrum of fields related to both civil and industrial engineering together with the fundamentals of law and specific seminars on structural failure prediction and assessment [3-12].

In Italy the professional engineer acting as consultant may serve either the judge as the “Court-Appointed Technician” (known as CTU) or the involved parts as the “Part-Appointed Technician”
In this context, a research centre entitled “Observatory Claudio Ceccoli” to the memory of Claudio Ceccoli, who was a pioneer in Italy in forensic engineering, has been established on January 2012 within the Department of Civil, Environmental and Materials Engineering (DICAM) of the Faculty of Engineering, University of Bologna. It represents one of the few Italian research centres which is entirely devoted in Forensic Engineer-related issues.

The centre has a multidisciplinary nature since it involves different categories such as the academia, professional engineers, architects, lawyers, and various companies (construction firms, insurances). In particular a close relationship has been established with the Court of Bologna through a specific research agreement which is based on the joint evaluation of the real cases.

In the present paper the aims and tasks of the centre are first clearly stated. Then, the fundamental activities of the centre are described. Finally some results as obtained from a statistical analyses of the real cases available from the Court of Bologna are presented.

2. The aims of the research centre

All the activities of the research centre are based on a close collaboration with the court of Bologna which shared the huge amount of data related to the civil or penal lawsuits involving defects on building structures.

The first activities of the centre, which were conducted over the first year (2012), has been mainly focused in a close examination of the past real cases as provided by the court of Bologna. That in order to identify typical causes, similarities among the analysed cases and eventual deficiencies.

The detailed analysis of the cases allows the identification of a number of issues which may deserve the attention of the research centre:

- The lack of a complete catalogue of defects of building structures may be useful to the consultant in order to recognize, classify and better understand the specific case under evaluation. Information may be found in [13]. The issue is of particular importance since in most real cases the claimed defect should be identified as an “expected” (even if undesirable) behaviour, i.e. an expected performance during the service life of the product. Another important issue arose from the analyses of the data deals with the definition of a relevant defect.

- The need of a methodology for the identification and quantification of risks associated to the defects identified on the building structures.

- The need of a unique “language” which could be shared by the technicians (i.e. the experts in the technical issues, e.g. engineers, architects) and the lawyers.

- The need of methodological guidelines for the developments of the technical consultants.

- The need of identifying precise responsibilities for the various actors involved in the court-disputes.

The critical analyses of the data lead to the identification of the fundamental objectives of the research centre. They can be classified as scientific objectives and practical objectives. The main scientific objective is to increase the knowledge on the defects of the building structures through the theoretical study of specific problems and through the analyses of real cases. The practical objectives are manifold, as the development of a web-based database in order to provide a guide for all the technical consultants during the different phases of their activities. The intent is to promote the use of the web-based database among the technical consultants in order to standardize the procedure and, at the same time, to acquire data in real time. Other objectives are the developments of a number of tools useful for the activities of the various actors involved in the field.

3. The main activities of the research centre

As above anticipated, the main effort of the first year of the centre was devoted into the
development of the collaboration with the Court of Bologna thought the examination of real cases. Nonetheless, an experimental release of the web-based database is already available. A detailed description of the web-based database is provided in the next section.

A list of the activities of the centre (some already activated, some intended) is:

- A continuum analysis of data of the web-based database.
- The diffusion of a periodic “Bulletin of Defects on Construction”, which starting from the expertise acquired through the analyses of the examined cases provides insights into a specific defect or class of defects.
- An updated (periodic) price list of the market value for typical building typologies, installations, furniture, finishes.
- The institution of periodic “Focus” to answer to specific questions which arise from the analysis of the examined cases.
- The divulgation (each year) of statistics as extrapolated from the analysis of the examined cases.
- The development of guidelines for the technical consultants dealing with the typical inquiry of the judge, the ethic profile of the consultant, the typical structure of a technical advice.
- The development of a web site. A preliminary version of the web site is available on line [13].

4. The rationale behind the web-based database

The web-based database has a sequential matrix-based structure which is used to store the fundamental information of a technical advice. The aim is to provide a standard protocol which can be used by the technical consultant [14-16]. The matrixes are focused on the following features:

- Matrix A provides the general information of the building affected by one or more presumed defects (i.e. building location, type, structural typology, age, etc.);
- Matrix B provides a description of each presumed defect (i.e. typology, location, extension, etc.);
- Matrix C provides the information related to the way the defect is effectively (or not) recognized (visual inspection, in situ tests, laboratory tests) and an estimation about the repairing costs;
- Matrix D collects the information related to the causes of the defect (poor material qualities, poor workmanship);
- Matrix E collects the information related to the responsibilities (the designer of the structure in elevation, the geotechnical designer, the architect, the building surveyor, the construction firm, the property);

The rationale behind the proposed matrix-based structure is to obtain a “cascade” structure which may guide step-by-step the technical consultants through the different phases of the process. Each matrix has a similar structure and is composed of 3 columns of increasing level of details:

- Column 1: contains the macro-areas of the related matrix;
- Column 2: contains the specific options related to the selected macro-area;
- Column 3: it further specify the option selected in the second column.

Figure 1 provides an illustrative example of the matrix structure (extracted from Matrix C: "Identification of the defects").
5. **Focus: on the “expected behaviour” and “relevant defect”**

This section provides an illustrative example of an important “focus” arose from the analyses of the data related to the definition of the “expected behaviour” and the “relevant defect”. As above anticipated, an unambiguous and detailed definition of the term “expected behaviour” could prevent most litigations from the beginning. The “relevant defect” is the defect that is relevant from the jurisprudence, therefore its unambiguous and detailed definition is also of fundamental importance.

5.1 **The “expected behaviour”**

A unique and unambiguous definition of “expected behaviour” appears not easy. In fact no definition of “expected behaviour” is actually provided by the jurisprudence (e.g. Italian Civil Code, referred to as c.c. [18]). Nonetheless, a recent reference may be found in a 1 grade judgment of the Court of Bologna which says:

“In other words, the present Judge considers that the whole state of the building could be referred to, according to the state-of-the-practice, the definition of “expected behaviour”, e.g. the state of common aging of the building structure due to the time, and therefore not ascribable to the seller and the construction firm”.

From a technical point of view the “expected behaviour” of a building structure is intimately related to the concept of “long-term behaviour” which may or not result in a degrading behaviour. The awareness of such response requires a notable expertise and relies in the technical tradition and manuals whose knowledge has been rapidly disappearing among the community. It is therefore necessary an extended research in order to collect the ensemble of knowledge necessary for a
5.2 The “relevant defect”

From the jurisprudence the “relevant defect” is stated in the art. 1669 of the c.c. which also clearly identifies responsibilities in presence of a “relevant defect”. Nonetheless, no detailed definition is provided by the jurisprudence.

From a technical point of view the “relevant defect” can be identified with a number of phenomena leading to:

- Building collapse (global or partial) under gravity loads;
- Excessive deformations or damages (also localized) which may preclude the functionality of the building structures or the comfort of the occupants;
- Degrading phenomena due to fatigue, corrosion, leakage, mildews.

Therefore the “relevant defect” is not limited to malfunctioning of the structural components, but can be also localized in the non-structural elements, such as partition walls, furniture, floors.

The above definition takes its origin from the actual Italian code structure, which is founded on the concept of limit states. It is clearly stated that the building structures have to be designed, realized, and verified in order to accomplish with the expected use and satisfy the prescribed levels of safety. The safety and performances of the structure are verified in terms of exceeding of a number of limit states (Italian building code, NTC08 [17]). Limit states includes Ultimate Limit States (ULS) related to the collapse (global or partial) of the structure and Serviceability Limit States (SLS) related to the malfunctioning of the building.

6. The statistics from the analysed cases

This section presents some statistics as extracted from the web-based database. Only the cases dated on 2011 are included. In detail a total number of about 120 is considered. Selected statistics are reported in the graphs of Figure 2.

Inspection of the graphs allows the following observations:

- The majority of defects have been discovered after the end of the works (almost 90%) in residential buildings (almost 80%).
- As far as the structural typology masonry buildings represent the 40% of the total.
- The defects are localized mainly in the elevation (almost 80% of the cases), while in 20 cases over 100 they were localized in the foundation or in the roof.
- A large variety of defects has been observed: the largest percentage of defects are related to poor workmanship, water infiltration, and incompleteness of the work (which all together represent almost one half of the total).
- Defects are quite equally distributed between structural components, pipelines and finishing.
- In more than one half of the cases the defect is caused by an inadequate execution or incompleteness of the works; then the poor quality of materials and poor maintenance follow.
- In one half of the cases the responsibility was attributed to the construction firm, followed by the owner and the tenant.
Conclusions

The present paper aims at promoting the activities of the research centre “Observatory Ceccoli”, recently established at the Department of Civil Engineering at the University of Bologna in close collaboration with the Court of Bologna. The research centre is entirely devoted in the field of Forensic Engineer which, nowadays, is assuming a relevant position among both the academia and professional engineers, as an own discipline. The research centre is characterized by a multidisciplinary nature, since it involves a number of different categories (the academia, professional engineers, architects, lawyers) and various companies (construction firms, insurances). The main scientific intent of the centre is to increase the knowledge in the field by an in-depth analysis of the real cases available from the court of Bologna. During the first year of activity, a web-based database has been developed in order to collect all the fundamental information from the analysed cases and, at the same time, to guide the consultant engineers toward the complex process of the technical advice. Additional activities are actually under development in order to enlarge the
covered topics and to involve further professional categories. The intent is to make the centre as a reference point for the local community of forensic engineers.

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References

[18] Codice Civile Italiano, Royal Decree of 16 March 1942, n. 262, Published in the Gazzetta Ufficiale (extra-ordinary edition), n. 79 of 04 April 1942 (in Italian)