

## Forensic Engineering in Italy: A Reality

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The start-up of a practice-oriented postgraduate master program on forensic engineering (FE) at the University of Naples Federico II, Naples, Italy, was the first institutional step for FE dissemination in Italy and continental Europe. That master program was established by Nicola Augenti (current director) on August 6, 2008, and covers a broad spectrum of fields related to both civil and industrial engineering (Augenti 2009a). Legal issues of engineering practice are taught by academics and judges in the frame of courses on law fundamentals and seminars. Four master program editions have concluded with great success, as shown by the increasing number of graduated forensic engineers that have been appointed by judges to investigate the causes of accidents. In some cases, graduated forensic engineers have been appointed by engineering and law firms in Europe. The master program introduced two main innovations: the inclusion of law fundamentals in the engineering education and the expansion of FE to industrial engineering. Such features gave the chance to organize a renewed conference series named IF CRASC, which is the Italian abbreviation of forensic engineering (IF) and collapses, reliability and retrofit of structures (CRASC). The idea of Nicola Augenti was to associate the main current FE areas with the traditional field of structural failure prediction and assessment, which was the subject of three CRASC Congresses in 2001 (Venice), 2003 (Naples), and 2006 (Messina).

The first IF CRASC Congress was held in Naples on December 2009 (Augenti 2009b), whereas the second Congress took place in Pisa on November 2012 (Augenti and Sassu 2012), demonstrating a growing interest of academics, professionals, private societies, and public administrations. Table 1 shows some interesting statistics of the IF CRASC Congress series. It is emphasized that the 2012 Congress proceedings had 93 additional printed pages compared with those published in 2009, even though the maximum number of pages per paper reduced from 12 to 10.

Both Congress proceedings and a handbook edited by Augenti and Chiaia (2011) shed light on the current broad meaning of FE, which is no longer restricted to the investigation of materials, products, components, or structures that fail or do not operate as intended, causing personal injury or damage to property. Actually, modern FE in Italy is being delineated as any investigation aimed at predicting/forecasting what can happen, assessing what has occurred, or mitigating/avoiding losses from white/black swan events. It is underlined that a white swan event is a known event with a given likelihood or certainty of occurrence, whereas a black swan event is an unknown unpredictable event that has a massive impact and can be rationalized only after its occurrence (Taleb 2007). This new framework makes FE a more general engineering field where classical consulting practice in the context of civil and criminal law cases

is just the most common activity. For instance, in the field of industrial engineering, forensic engineers are often appointed to assess whether a product or system operates at a performance level not lower than that guaranteed by the supplier. Otherwise, the user can be interested in claiming a price reduction when buying the product or system, and no civil law case begins. This reflects the evolution of FE. The latter was born as a structural engineering field strictly associated with litigation, where the forensic engineer investigated the causes and responsibilities of a failure or collapse. Afterward, FE was extended to many other nonstructural fields of civil engineering and also to industrial engineering. Today, FE is a more complex engineering field that includes any study of an unexpected/unpredictable event, or poor performance, which has occurred or can happen. In other words, FE activities are more frequently performed outside lawsuits, generalizing the literal meaning of the term forensic as adjective related to the courtroom.

The expansion of FE to other areas is reflected by the types and amount of contributions presented during the IF CRASC '12 Congress (Fig. 1), which took place under auspices of the Italian Council of Engineers [whose official Italian denomination is Consiglio Nazionale Ingegneri (CNI)]. Although the number of studies falling in the fields of structural forensics, structural retrofitting, and industrial FE was almost equal to that of the 2009 Congress, a significant increase in the amount of papers was recorded in the areas of structural reliability, civil FE, and legal issues of engineering practice.

Preliminary outcomes of a forensic investigation on the collapse of Schola Armaturarum in the archeological sites of Pompeii, Italy, was presented. Interesting case studies of industrial FE included the back-analysis of gas pipeline explosions and the impressive fire of the ThyssenKrupp plant in Turin, Italy, which occurred on December 6, 2007, causing seven deaths. A virtual reality reconstruction of the accident allowed forensic engineers to identify the causes and responsibilities. The famous disaster of the cruise ship Costa Concordia, which partially sank on the night of January 13, 2012, after hitting a reef off the Italian coast and running aground at Isola del Giglio, Tuscany (central Italy), was discussed from a legal standpoint.

In the structural reliability area, the Congress papers focused on innovative scenario-based, probabilistic, and stochastic approaches related to different types of risk (e.g., progressive collapse caused by blast loads or fire, time-dependent seismic risk assessment).

In the field of civil FE, the Congress papers covered issues relating to geotechnical, environmental, and acoustical engineering, as well as construction management and new technologies for land monitoring and detailed survey of constructed facilities. Special flying robots were shown to be effective tools for the survey of inaccessible sites after large structural collapses, such as those caused by the 2009 L'Aquila earthquake (Augenti and Parisi 2010) and 2012 Emilia Romagna earthquakes (Parisi et al. 2012). A special contribution on a complex forensic investigation for the identification of an advanced underground gangster bunker was also presented, showing the relevant role of FE in the justice administration. Studies on the performance assessment of materials, products, constructed facilities, and environment used reverse engineering concepts and methods, including field inspections, acquisition and examination of project and management documents, back-analysis, comparison between observed and theoretical data, and identification of the causes and responsibilities of poor performance.

**Table 1.** Statistics of IF CRASC Congress Series in Italy

Material	IF CRASC '09 Congress	IF CRASC '12 Congress
Number of papers	56	82
Number of authors	93	165
Number of participants	90	90
Number of sponsors	3	7
Number of proceedings pages	751	844

**Fig. 1.** Round table at the end of IF CRASC '12 Congress in Pisa, Italy

The dissemination of FE in Italy is the main task of the Italian Association of Forensic Engineering (whose Italian acronym is AIF), which was established in Naples, Italy, on November 2009 (<http://www.aifitalia.it/homeenglish.html>). AIF promotes FE through the IF CRASC Congress series, seminars, and short courses. Augenti (2012) presented the AIF mission, statute, and organization chart; the AIF mission also includes a cooperation with similar associations and committees, such as the ASCE Technical Council on Forensic Engineering.

Finally, a FE national committee was founded in Rome in the frame of CNI. This committee has the following mission: (1) to promote the official recognition of FE as an engineering professional

skill; (2) to develop a national list of forensic engineers; (3) to define FE practice rules; and (4) to support education programs in the field. The existence of postgraduate education programs plays a key role. In this regard, it is worth noting that Nicola Augenti gave a series of four seminars in 2011 at University of Naples Federico II, Naples, Italy, to teach FE fundamentals to judges and their assistant police officers. That initiative was explicitly requested by the law court of Naples and was aimed at promoting an effective cooperation between judges and forensic engineers in Italy. The paper presented at the Congress describing the forensic investigation that identified the location of the bunker used by a gangster, leading to its capture, is an excellent example of such cooperation.

Many institutional and practical issues still remain to be solved in the years to come to reach a satisfactory quality level of FE practice in Italy. Nevertheless, we believe the activities presented in this forum can be an effective way to go, and our goals are quickly becoming a reality. We invite all interested people to follow our initiatives and to attend the next IF CRASC Congress, which will be held at University of Rome La Sapienza in 2015.

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