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ABSTRACT

To rationalize a natural disaster in a post-catastrophic stage, operational planning and prevention is totally necessary. The inspection procedures, the monitoring and the recovery of the constructions after a devastating effect must be accurate and complete in order to achieve rapid restoration of social and economic conditions and the safe return of the residents to their properties. The impact evaluation consists of the ability of the population and the Government (Local and Central), both, to effectively respond to devastating events and conditions as well as with the implementation of well-designed response, inspection, compensation, reconstruction and rehabilitation procedures.

This paper examines the inspection, compensation, reconstruction and rehabilitation procedures of the built environment after an earthquake. The June 8, 2008 Andravida (Greece) earthquake and the April 6, 2009 L’Aquila (Italy) earthquake were selected as comparative case studies. These earthquakes were mainly chosen due to their timing in two neighboring countries of the European Union. The research performed for the purposes of this project was based on interviews and field research and an extended literature and desk research. Interviews were conducted with Greek and Italian representatives and officials; the current legislation (in Greece and Italy) was carefully reviewed. Greek and international literature and web sources of information were used, along with an extensive evaluation of the available archives of the Earthquake Damaged Buildings Compensation Service (current Natural Disasters Damaged Buildings Compensation General Division) (Greece) and the information provided by the Italian Civil Protection.

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Introduction

During the past decades natural disasters have been seriously increased in Europe. The phenomena are particularly intense at the southern part of the European Continent. Due to the subduction of the African Plate under the European Plate, catastrophic seismic events are quite frequent at the Southern European Countries, mainly in Greece and Italy. Natural disasters and especially earthquakes, apart of human casualties, have direct and long-
term impact on the structural environment and the socioeconomic structures of the affected areas. This paper examines the inspection and reconstruction procedures of the built environment after an earthquake within the European Union. The June 8, 2008 Andravida (Greece) earthquake and the April 6, 2009 L'Aquila (Italy) earthquake were selected as comparative case studies. The research covers the procedures and results in each country within a two year time frame after each event which is considered an adequate period to produce sufficient conclusions on the post seismic procedures.

**Inspection, Compensation & Reconstruction Procedures in Greece**

Natural Disasters Damaged Buildings Compensation General Division (G.D.A.E.F.K.) is responsible for the evaluation of the damages caused to buildings and other constructions by natural disasters, estimate their competence and compensate all related parties, as well as to formulate a new compensation strategy for future phenomena in Greece. The General Division was founded as Earthquake Damaged Buildings Compensation Service (Y.A.S.) after the big Attica earthquake in 1981. G.D.A.E.F.K. answers directly to the Minister of Infrastructures and Transport. It has the authority and the ability to decide, if it is necessary, the institution of new Offices and Units all over the country, according to the incident and draw up the relevant Ministerial Decrees.

Right after an earthquake, in order to estimate the seriousness of the incident and to evaluate the damages, committees of engineers carry out macroscopic inspections on the spot. Whenever the available manpower of engineers is not enough or not available (large scale incidents or more than one incident at the same time), the Division may also use other engineers working at the General Secretariat of Infrastructures, and the related Local Authorities (Municipalities and Regions). The inspections are the First Degree Inspection and the Second Degree Inspection. Two-member committees of engineers (at least one of them has to be a Civil Engineer), carry out the First Degree Inspection on the spot. Depending on the scale and the seriousness of the damages, the inspection is carried out on application (written or not) by the interested party or by performing a “door to door” inspection in order to cover the damaged area. The committees fill out a First Degree Inspection Form per building and forward a copy to the interested party (owner, proprietor, etc.). The buildings and the constructions are marked as “fit for habitation” (suitable to use) or “not fit for habitation” (temporarily not suitable to use), depending on the observed damages.

All the buildings and the constructions marked as “not fit for habitation” during the First Degree Inspection on the spot, have to pass through the Second Degree Inspection on the spot. This procedure takes place without any application made by the interested parties, unless the construction was (for any reason) not examined, during the First Degree Inspection on the spot. Priority is given to the most seriously damaged constructions. The committees fill out a Second Degree Inspection Form per building and forward a copy to the interested party along with a leaflet with all the necessary information about the compensation and relevant procedures. The Second Degree Inspection on the spot is carried out by a two-member or a three-member committee of engineers, serve at the Natural Disasters Damaged Buildings Compensation General Division. At least one of the members has to be a Civil Engineer. During the Second Degree Inspection, and depending on the observed damages, the buildings and the constructions
are marked as:
- “suitable to use”: GREEN,
- “temporarily not suitable to use”: YELLOW
- “dangerous to use”: RED

It is easier for the population to follow and understand the colour markings on the buildings instead of a technical term description of the damages. Since this procedure is used for more than thirty years, most Greeks are, by now, familiar with it, and know exactly what to do after an incident.

The First Degree Inspection Form and the Second Degree Inspection Form, both are single page forms with basic information about the owner and the building address.

For the buildings/constructions marked as “dangerous to use”: RED, during the Second Degree Inspection, the three member committee of engineers draw up the Demolition Protocol. The Demolition Protocol is a 4 page form which includes the name and reference of the owner, the address of the condemned building, a rough drawing of the building and indicative photographs of the observed damages.

After an earthquake, the completion at least of the First Degree Inspection is required, so that the Natural Disasters Damaged Buildings Compensation General Division is aware of the scale and the seriousness of the incident; a Common Ministerial Decree is issued, defining the exact areas that suffered by the phenomenon. The Common Ministerial Decree is co-signed by the Minister of Infrastructures and Transport and the Minister of Finance.

The Common Ministerial Decree also sets the measures and the rules for the compensation of the constructions damaged by the earthquake. The constructions (public or private properties) can be repaired or reconstructed, depending on the decision made by the Second Degree committee of engineers.

The redundancy payment, called “Housing Assistance”, consists of a non-interest loan and a free contribution (financial aid) by the Government and is granted in three separate installments. A Ministerial Decree, signed by the Minister of Infrastructures and Transport, sets fixed prices for the repair of the damaged properties. The G.D., after calculating the area of the property that has to be repaired or reconstructed, estimates the total sum based on the Ministerial Decree. Other Ministerial Decrees set the terms and rules for the monthly subsidies, the deadlines for the applications, the temporary housing, etc. “Housing Assistance” is also granted to the properties marked “suitable to use”: GREEN if they present damages.

After the publication of the Common Ministerial Decree, the G.D. continues the inspections at the affected area by application of the interested parties. At this case an Inspection Report is issued which can be used for the compensation of the building, if damages are detected.

Depending on the scale of the event, the Minister of Infrastructures and Transport decides on a rent subsidy for temporary housing which is granted up to two years for the homeowners and three months for the leasers of the damaged buildings. In some cases containers and trailers are placed in private plots nearby or within the affected area.

**The 2008 Andravida Earthquake**

A strong earthquake of magnitude $M_W=6.5$ occurred in western Greece near Andravida on June 8
2008 at 15:25 local time (12:25:28.0 UTC). The earthquake was felt in most of the country, Crete, as well as in Southern Italy and Albania, resulting 2 deaths, more than 200 injured people and significant damages in buildings and infrastructures at the Achaia, Ilia and Aitolioakarnania Prefectures.

The First Degree Inspection started on the day of the earthquake by the Engineers of the Local Units of the Earthquake Damaged Buildings Compensation Service (Y.A.S.) cited at Patra and Pyrgos. The Local Units also served the purposes of co-ordination procedures and public information. The inspection procedures continued on June 9 2008, with engineers and administrative employees from the central offices of Y.A.S., the Local Governments, various Ministerial Services and the Earthquake Damaged Buildings Compensation Service of Northern Greece (Y.A.S.B.E.). 655 employees were deployed for the inspection procedures and administrative needs: 210 from Y.A.S and 445 from other Services and Y.A.S.B.E. The First Degree Inspection completed almost one week after the earthquake. In total 31,153 buildings/constructions were inspected, resulting 21,481 of them marked as “fit for habitation” (suitable to use) and 9,672 marked as “not fit for habitation” (temporarily not suitable to use). The Second Degree Inspection started right after the completion of First Degree Inspection. The whole process lasted until July 16 2008. Priority was given to the buildings/constructions characterized as “not fit for habitation” and potential hazardous. Buildings/constructions without a First Degree Inspection Form were also inspected by written application from the owners. In total 9,134 buildings/constructions were inspected in the 3 affected Prefectures, with 2,141 of them marked as GREEN, 5,630 marked as YELLOW and 1,874 marked as RED. The numeric discrepancy is due to the fact that certain buildings had double characterization (i.e. GREEN on the ground floor and YELLOW on the upper floor).

On July 8 2008, a month after the event, the no 5322/A32 Common Ministerial Decree (Government Gazette no 1336/B/08.07.2008) was issued, defining the exact areas that suffered by the earthquake and stating that the “Housing Assistance”, for the affected constructions will consist only by free contribution (financial aid), from the Government and will be granted in two installments for the repairs and in three installments for the reconstructions. In September 2008 the supplementary C.M.D. no 7320/A32/19.09.2008 (G.G. no 2007/B/29.09.08) was issued, covering necessary details and technical issues.

By the end of 2010, a total number of 4,854 buildings/constructions needed repairs by the owners, whilst the condemned ones rose up to 1,285. 39% of the approved repairs and 34% of the approved reconstructions were completed in the three affected Prefectures. A sum of €36,420,866.52 was granted for repairs and of €16,234,876.27 for reconstructions.

Prefabricated little houses (containers) and trailers were provided in order to cover temporarily the housing demands of the population in the earthquake damaged area in case of buildings marked as YELLOW or RED by the Second Degree Inspection committee and if the owners or other interested parties requested. Also, a rent subsidy was decided by the Government for the people willing to rent safe apartments nearby until the completion of their properties. By the end of 2010, 463 containers of 25m², 36m², 50m² and 27 trailers were placed in the affected areas. At the same period of time a rent subsidy of €2,601,866 was granted.
Inspection, Compensation & Reconstruction Procedures in Italy

The Italian Government first adopted the term Civil Protection in 1970 as aid and support to natural disasters victims. The present form of the Italian Civil Protection Service formulated in 1992 and finalized after a series of supplements and corrections to the relevant Legislation in 1998 and 2001. According to the current legislation the C.P.S. is represented to the Council of Ministers by the Minister of Civil Protection and answers directly to the Prime Minister. During emergencies and crisis C.P.S. has the authority and the ability to directly activate the relevant voluntary groups from all over the country. In Italy 40% of all action groups from every area of expertise, are volunteers.

For the collection and data management a complete electronic information system is used under the name AUGUSTUS METHOD (after Augustus Caesar). Public sector (Central Government, Ministries, Regions, Prefectures, Municipalities and Local Councils), specialized scientific institutes (Universities, Research Centers and Institutes), and private sector (voluntary non-governmental organizations and civilians), are involved and co-operate under the Method.

Catastrophic events are divided in three categories depending on the seriousness of the effect and the affected area. The relevant Control and Operational Centers are activated respectively. During big national disasters (category c events) the General Decision and Control Center (Direzione comando e controllo: Di.Coma.C.) is activated. Di.Coma.C. supervises the Aid Co-ordination Center (Centro coordinamento soccorsi: C.C.S.) which operates on Regional level (category b events). The General Center of Operations (Centro operativo misto: C.O.M.) and the Municipal Center of Operations (Centro operativo comunale: C.O.C.) (category a events) operate on Municipal level.

Inspection on residential buildings and on buildings/constructions of public use and interest is carried out by volunteer engineers, under the general co-ordination of Di.Coma.C. The entrance to the buildings/constructions is allowed to the Engineers after a security control performed by specialists from the National Fire Department. Churches, monuments and constructions of cultural interest are inspected by University Professors (Engineers and Archeologists of expertise), under the supervision of the Ministry of Cultural Heritage. The relevant Usability Assessment Forms are used by the Inspection Committees for every purpose.

The 1st Level Form for Post-earthquake Damage and Usability Assessment and Emergency Countermeasures in Residential Buildings is a three page form with directions explanatory compiling notes. Depending on the observed damages and the risk evaluation, the buildings are marked as A: USABLE, B: UNUSABLE (totally or partially), but USABLE after short term countermeasures, C: PARTIALLY UNUSABLE, D: TEMPORARILY UNUSABLE (requiring a more detailed investigation), E: UNUSABLE and F: UNUSABLE due to external risk. The Usability Assessment Forms for Churches and Monuments and Constructions of Cultural Interest (Palazzi), are similar with the residential one with extra details about the structural elements and drawings of the damages. All the above mentioned Forms include codes for information and data collection purposes.

The Italian Government takes full responsibility for compensation and reconstruction of all the affected buildings/constructions. Repairs and reconstructions are assigned by Prime Ministerial
Decree to local Construction Companies. Funding is forecasted by the relevant legislation and on the Government Spending Plan and gets approved by the Ministry of Economics and Finance. Owners of the damaged buildings have the ability to choose a contractor of their own. In this case compensation is paid by demonstration of the relevant receipts while Civil Protection Service supervises the work progress.

For temporary housing needs of the affected population, tent camps are used where needed. For longer periods of time, there are two housing programs in use: M.A.P. (Moduli Abitativi Provvisori) Program and C.A.S.E. (Complessi Antisismici Sostenibili ed Eocompatibili) Program. M.A.P. are one or two storey prefabricated timber houses. C.A.S.E. are two or three storey energy autonomous complexes of timber and reinforced concrete, with metallic elements, based on seismic isolated plates [1], [2]. All the houses are delivered fully equipped and furnished, while there is a future plan for their use by Local Authorities and Universities (after the homeless citizens return to their own properties). C.A.S.E. houses were manufactured and used for the first time at L'Aquila earthquake.

There is also the M.U.S.P. (Moduli ad Uso Scolastico Provvisori) Program, for the construction of prefabricated buildings for schools.

**The 2009 L'Aquila Earthquake**

L'Aquila earthquake occurred on April 6 2009 at 03:32 local time (01:32 UTC). According to the Istituto Nazionale di Geofisica e Vulcanologia (I.N.G.V.), the magnitude of the earthquake was \( M_w = 6.2 \) (I.N.G.V.) and was felt all over Italy. The earthquake struck the broader region of L'Aquila resulting 308 deaths and over 1.000 injured people and extensive damages.

Di.Coma.C. was activated during the first hours after the earthquake. Inspection started on April 7 2009 giving priority to public buildings, schools, hospitals as well as to industrial and commercial establishments [3]. Two days after the event, inspections on the residential buildings started by Committees of Engineers from the Public and Private Sector of Italy. Engineers from other European Union countries (Spain, Portugal, Slovenia, Germany and Greece), contributed to the inspection procedures, on missions deployed by the European Mechanism of Civil Protection. The inspection teams were also joined by a group of technicians sent by the Ministry of the Russian Federation for Affairs of Civil Defense, Emergencies and Disaster Relief (EMERCOM) [3]. Almost 8,500 Engineers were deployed (in total) and over 300 specialists got involved with the pre-inspection procedures and data collection and classification. By March 2010 Committees carried out 80,000 inspections on 62,952 public, private buildings and industrial establishments. The numeric discrepancy is due to the re-evaluation for more detailed inspection of certain buildings. The complete results of the inspections characterized 52.6% of the buildings USABLE (Category A), 30.6% as UNUSABLE or UNUSABLE due to external risk (Categories E and F). 16.8% of the inspected buildings listed on the rest characterization categories [4], [5].

2/3 of the buildings in the city of L'Aquila presented noticeable damages [3] while entrance to the historical center was prohibited as it was marked as Red Zone (zona rossa).

Experts from the Universities of Genoa, Padua and Milan carried out the usability inspections on the churches, monuments and the historical buildings (palazzo) [6]. 1,800 inspections on 1,388 constructions result that 52.8% of the buildings were marked as UNUSABLE (Category E) and
23.3% USABLE (Category A) [4], [5].

On the 6th of April the Italian Government started the necessary legislative procedures to cover all the relevant issues (i.e. co-ordination and funding, temporary and long term housing, repairs and reconstruction of the damaged buildings in the affected area, etc.), in the forms of Presidential Orders, Prime Ministerial and Ministerial Decrees, Prime Ministerial Directives, etc. The 77/24.06.2009 Law (G.U. No. 147/27.06.2009) set the exact compensation procedures and stated the construction of the M.A.P. and C.A.S.E. houses. Specifically, for the reconstruction or the repairs on secondary residencies and professional constructions, 80% of the expense is covered by the State and up to €80,000. For main residencies the whole amount is covered. For the buildings under Category A the sum of €10,000 is granted for the repairs of non-structural elements and €2,500 for the repairs at the commonly shared parts of the buildings. Repairs in masonry constructions are fully funded. All payments increase by 30% for necessary seismic improvements.

On May 2009, appropriate areas were selected for the construction of the M.A.P. and C.A.S.E. prefabricated houses and the legal procedures for the selection of the qualified construction companies started. The M.A.P. and C.A.S.E. houses were given to homeless citizens whose residencies were either under the categories E and F or inside the Red Zone. According to the C.P.S. the construction works of M.A.P. houses started in August 2009 and the first houses were delivered to the regional Municipalities in October and to L’Aquila area on December the 30th 2009. In total, 3,535 M.A.P. houses were built in all affected areas. 1,273 houses were built in the broader area of L’Aquila (160 were donated). On the other Municipalities 2,262 houses were built (209 were donated). The total cost of the Program was €236,000,000 (€100,000,000 for L’Aquila and €136,000,000 for the other areas). The M.A.P. Program completed on March 31 2010.

For the realization of the C.A.S.E. Program a single-purpose consortium was created (named ForCASE), formed by Eucentre (a non-profit foundation, center of competence for seismic risk of the department of Civil Protection, founded by four public institutions and with a nature of ‘public company’ in Europe) and two construction companies, (ICOP and Damiani). The two companies agreed to operate in this context as nonprofit entities and not to participate in any other reconstruction activity in Abruzzo [2]. Construction works started in June 2009 by 14 construction companies. 185 buildings (4,449 apartments) were built, 35 more than the original planning. The total cost of the Program was €815,000,000 (€350,000,000 granted by the E.U. and €36,000,000 covered by donations). The first 400 C.A.S.E. residencies delivered on September 29 2009. The Program completed on February 19 2010.

The M.A.P. and C.A.S.E. Programs covered the housing needs of 24,000 people by March 2010. It is estimated that the relocated families will stay in the prefabricated houses for 10 – 15 years. A year after the earthquake 6,646 people were still homeless, living in hotels, in barracks and in rented private houses [4], [5]. Two years after the event, more than 14,000 are still there according to Massimo Cialente, Mayor of L’Aquila.

Unfortunately repairs and reconstructions in the affected areas were extremely slow. By the end of 2010 the repairs outside the Red Zone were not completed, so only a small part of the population returned to their houses. At the end of 2011 very few buildings inside the Red Zone were repaired and the area was still off limits. As a result, L’Aquila seemed like a dead city with
most of the productive population migrating to other areas. Because of the relocation of the population and the debarment of the affected areas, a lot of the industrial and commercial units moved their business to other areas of the country. As a consequence approximately 26,000 people lost their jobs. The official unemployment rate in the area is 12.2% (40% of young ages), which is higher than the national average [7], [8].

All the above caused considerable increase on the anxiety, stress and depression levels; 43% of the affected population suffers or suffered from post-traumatic stress (66% are women), while only 65% still had a job, alcohol and drug use are also increased [9].

Conclusions

In both countries post-earthquake inspections are carried out macroscopically, so it is not easy to observe non apparent damages on structural and non-structural elements of the affected buildings/constructions. Nevertheless, this way is considered as the most appropriate for the immediate estimation of the seriousness of the incident and quick evaluation of the damages.

In Greece, the Usability Assessment Forms are single page forms providing only basic information about the damaged buildings (address, ownership, characterization), with main advantage their fast completion during the inspections. First disadvantage of the Forms is the lack of the exact location of the construction, while the only information about the owners is their names. Although, there is a geographical coordinates field, the Inspection Committees are not equipped with the instruments to fill it out. This fact, along with the non-existing cadastral maps, and the lack of a data information system, leads to the repeat of the inspections and the inability of the data process for future use. Second disadvantage is that the damages are not described in details but only by the characterization of the building. Therefore, damage data collection and classification per construction type (like the Italian Forms), is not possible.

In Italy, the Usability Assessment Forms are multiple page forms, requiring a lot of filling out time which leads to the delay of the inspections completion. Apart of the fact that the fields relating to the reinforced concrete constructions are few and brief, Italian Forms are precise and easy to compile. The detailed description per structural element, provide all the necessary information about the seismic behavior of the damaged buildings, considering the type and the time of the construction. This fact supplies the Authorities with an adequate estimation of the financial aid for the affected areas.

Augustus Method has the advantage of direct conclusions, further information process and data comparison in case of future events in the same geographical areas. Such a system does not exist in Greece which results to double inspections or even compensations for the same buildings/constructions.

There are also differences on the issue of the Decrees for the definition and recovery of the affected areas and the compensation for the damaged constructions. The authorities, given by law, to the Italian Civil Protection, minimize the required procedures. The Greek system is clearly more bureaucratic and time consuming.

The Italian Civil Protection is directly involved in the repairs, reinforcements and reconstructions of the earthquake damaged buildings by supervising the work progress, keeping detailed records of all the operations and the technical interventions. In Greece the Engineers of Natural Disasters
Damaged Buildings Compensation General Division simply sign the acceptance of a completed building without supervising the works or being aware if the approved plan is actually realized and the ability to estimate and assess the actual seismic behavior of the construction is not possible during future earthquakes.

The complete evacuation of the affected areas by temporarily relocating the population in prefabricated constructions, in Italy, is considered an excellent solution. It is actually remarkable the fact that fully furnished and equipped residencies are completed in only four months. Apart the efficient plan and operation of the project, at L'Aquila earthquake, there was no provision for basic issues such as transport networks, commercial and enterprise activities and the socioeconomic status of the earthquake damaged area, which resulted to serious economic, professional and social dysfunctions. A similar project could not be materialized in Greece for several reasons. The still existing strong family and community bonds along with the high spirit of ownership prevent the movement of population in areas more than a few kilometers from their properties and businesses. The fact that repairs and reconstructions rarely take more than three years is also a reason. In most cases people tend to either rent a property near their own or stay with friends or relatives until construction work is over. Another reason is the heavy bureaucracy and lack of funding.

Both countries handled efficiently and successfully the Andravida and L'Aquila earthquakes according to their resources and the national legal framework. Improvements are necessary in the Greek Mechanism, especially on the Inspection Forms, the compensation procedures, the funding process and the bureaucracy.

References