

Post-earthquake emergency assessment of building damage, safety and usability—Part 2: Organisation

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Abstract

The purpose of this paper is to describe the organisational aspects of the planning, setting up and execution of building inspection operations under emergency conditions, created by damaging earthquakes. The procedures developed herein reflect experience from damaging earthquakes in Greece and elsewhere and were tested in a pilot trial in the Greek city of Chania, with the purpose of adapting them in the overall earthquake emergency response plan of Greece. A computer program, PEADAB (for Post-Earthquake Assessment of Damaged Buildings) has been developed to support the planning and execution of such operations. Technical aspects of the operation are described in a companion paper (Part 1).

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1. Introduction

When a damaging earthquake hits a populated area, one of the first actions that authorities must take is to inspect all the buildings in the affected area in order to identify safe and unsafe buildings, so as to avoid death and injuries resulting from aftershocks. Identification of all safe buildings for immediate use will minimise the number of homeless, thus reducing the required temporary shelters and the load for emergency provisions. The inspections will be part of an earlier planned operation designed to cover efficiently and reliably large numbers of affected buildings under the usually chaotic emergency conditions created by the earthquake. Emergency interventions will be carried out to demolish dangerous buildings or portions thereof and provide shoring to weakened buildings to protect them from the aftershock sequence. Crucial factors for the success of such an operation, which is obviously quite important to get life in the affected areas back to normal, are its advance planning, the familiarity of the responsible

authorities with the required actions to quickly set up the operation, and the training of the personnel involved, especially the engineers–inspectors. The technical aspects of such operations are presented in the companion paper [1]. The present paper deals with the organisational aspects and is based on recent [2–4] and on earlier work [5–9].

2. Objectives of the operation

A prerequisite for the success of the operation is to have clear and well-defined objectives well known and understood by all the people involved. In particular, the engineers–inspectors, key personnel in this operation, should keep them always in mind in order to optimise their time and efforts. Ranked by their importance, there are two objectives, primary and secondary.

Primary objectives: (1) protect human life and (2) save properties.

Secondary objectives: (1) minimise the number of homeless and the loss of economic activity, by identifying as soon as possible all buildings that are safe to occupy and use, (2) indicate unsafe areas around hazardous buildings, identify temporary shelter sites and provide the number of

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required temporary housing units, (3) provide the necessary data for obtaining reliable estimates of the disaster that will allow authorities to take relief measures, formulate disaster mitigation policies and allocate available resources, (4) provide data that will identify frequent causes of damage, so that potential rehabilitation plans may take into account such information and (5) provide data for practical research studies that may lead to re-evaluation of existing codes and construction practices, to updates of seismic hazard maps and to elaboration of seismic vulnerability models for pre-earthquake planning purposes.

3. A brief overview of the inspections operation

After the occurrence of an earthquake, a field office is set up to be in charge of the inspections operation and of the emergency interventions.

The emergency inspections are carried out by teams of structural engineers and can be rapid or detailed (see Fig. 1). The rapid inspection is first carried out to screen out obviously safe or obviously unsafe buildings and is

followed by a detailed inspection of those buildings that have not been identified as safe by the rapid inspection. The detailed inspections will normally start after completion of the rapid inspections, at a time when hopefully the aftershock activity has subsided. Along with information about the building, its location, usage, structural type, etc., the observed damage is recorded and assessed in a specially designed Earthquake Damage Inspection Form (EDIF) following the damage classification and guidelines listed in the companion paper [1] and in a Field Manual [3]. Different parts of the EDIF are filled during each type of inspection. On the basis of the recorded damage and following again specific guidelines [1–3], an assessment for safety and usability is made and the building is posted as: Green, Yellow, or Red.

As part of this operation, buildings requiring urgent intervention are identified and marked on the EDIF along with an estimation of urgency. Depending upon the urgency, an intervention crew will be dispatched to apply the necessary measures. The members of the crew are provided with an Emergency Intervention Form on which they mark the work accomplished and further measures to be taken. Access to hazardous areas is blocked using special red–white tape.

The planning, setting up and execution of the operation are supported by PEADAB (Post-Earthquake Assessment of Damaged Buildings, Appendix C), a computer system designed specifically for this purpose [4]. PEADAB can provide substantial help and guidance so that the operation is organised and carried out efficiently and without delays. During the phase of execution PEADAB processes on a continuous basis the inspection forms brought to the field office by the inspectors, and provides a great deal of useful information about recorded damage as the operation progresses (see Appendix C).

4. Damage assessment

Damage assessment of buildings is made by inspection teams of engineers. Ideally there should be two structural engineers per team, with pertinent experience and/or previous training for the task.

The inspectors have to fill in the EDIF [1], in which the characteristics of the buildings inspected, their degree of damage as well as the recommendations for further action will be marked. Furthermore, an appropriate posting placard (Fig. 2a–c), indicating the classification of the building into one of the three categories, must be placed at or near all entrances of the building to be clearly visible by anyone who wants to enter. To discourage removal of the placard, a permanent spot should also be marked on the building next to the placard, by use of a spray of the same colour i.e. green, yellow or red.

If urgent intervention is needed (e.g., shoring, removal of some local hazard, demolition), it is marked on the EDIF, as well as on the posting placard. In case leak or damage to utilities is suspected (i.e., electricity, water, or gas), the

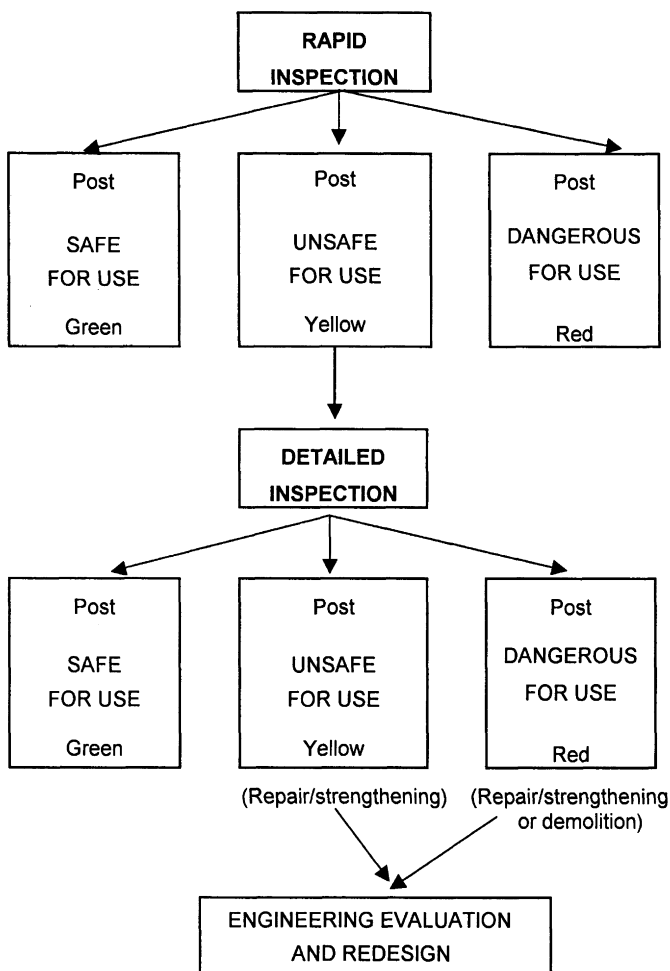


Fig. 1. Damage, usability and posting classification of buildings.

utilities have to be disconnected. Hazardous and unsafe areas have to be barricaded with red–white tape and access to them is prohibited.

If the building is safe except for some easy-to-remove localised hazard (e.g., damaged chimney or parapet wall), it may be posted Green with restrictions, and access to the dangerous area must be prohibited. Obviously unsafe structures should not be entered but should be posted Red.

A copy of the signed inspection form is given to the owner or the building manager, and the purpose and meaning of the posting are explained to the occupants.

5. Rapid inspection

The purpose of the rapid inspection is to quickly screen out the obviously safe and obviously unsafe buildings, thus minimising the number of those buildings that need a more time consuming detailed inspection. The outside of the building is inspected and, only if safe, the ground floor. It should take 10–30 min per building.

The outside of the building is examined visually for damage to bearing elements or to secondary elements (chimneys, roof, infill walls, façade, etc.) and for signs of residual drift of the whole building or parts of it. Care should be exercised for possible preexisting out of plumb. Signs of permanent displacement at the ground level, e.g. small gaps between columns and ground, should be checked.

6. Detailed inspection

The detailed inspection is aimed at providing a more reliable estimate of the condition of the building. It is carried out for all buildings posted Yellow or Red after a rapid inspection, for all critical facilities (hospitals, police and fire stations, etc.) and for other important structures (e.g., schools). It is also carried out for buildings posted Green if there is information or indication of damage, e.g. missed during the rapid inspection or due to continuing aftershock activity. The new posting may be different from

SAFE FOR USE

ADDRESS	SECTION No
DATE OF INSPECTION	TIME:.....
CREW No	REPORT No.....
INSPECTION TEAM DATA 1. Name/ Title Signature 2. Name / Title Signature	

The building is in general safe and may be used under the occasional restrictions as indicated.

<u>TYPE OF INSPECTION</u>	
RAPID (1 st) ☐	DETAILED (2 nd) ☐
<u>RESTRICTIONS IN USE – SAFETY MEASURES TO BE TAKEN</u>	
NO RESTRICTIONS ☐	
ACCESS TO THE FOLLOWING AREAS IS PROHIBITED:	
THE FOLLOWING ELEMENTS SHOULD BE DEMOLISHED OR REMOVED:.....	
.....	

**DO NOT REMOVE THIS PLACARD UNTIL PERMISSION IS GIVEN BY
LOCAL AUTHORITIES**

Fig. 2. Posting placards for buildings assessed (a) safe for use (Green), (b) unsafe for use (Yellow), (c) dangerous for use (Red).

UNSAFE FOR USE

ADDRESS	SECTION No
DATE OF INSPECTION	TIME:.....
CREW No	REPORT No.....
INSPECTION TEAM DATA	
1. Name/ Title	Signature
2. Name / Title	Signature

The building has suffered damages (as indicated in the inspection form) and cannot be used before the detailed (2nd) inspection takes place. Entry only at own risk and only for a limited time period. Aftershocks may cause injury or even death. Safety measures stated herein have to be taken immediately.

TYPE OF INSPECTION	
RAPID (1 st) ☐	DETAILED (2 nd) ☐
<u>RESTRICTIONS IN USE – SAFETY MEASURES TO BE TAKEN</u>	
URGENT SUPPORT REQUIRED ☐	
ACCESS TO THE FOLLOWING AREAS IS PROHIBITED:	
THE FOLLOWING ELEMENTS SHOULD BE DEMOLISHED OR REMOVED:	
.....	
THE FOLLOWING UTILITIES MUST BE DISCONNECTED:	
ELECTRICITY ☐	WATER ☐ GAS ☐
OTHER:	

**DO NOT REMOVE THIS PLACARD UNTIL PERMISSION IS GIVEN BY
LOCAL AUTHORITIES**

Fig. 2. (Continued)

that of the rapid inspection. Depending on the size of the building, the detailed inspection is anticipated to take anywhere from 1–2 h.

Initially the building is examined from the outside before entering: all evident structural and non-structural damage is observed, as well as ground problems or geological hazards (settlements, ground fissures, signs of liquefaction and, in case of hillside buildings, signs of slope movement and rockfall hazards). Then, and on the condition that it is considered safe to do so, the building interior is examined. The team should proceed from the ground storey upwards and inspect every floor including penthouse and roof, not forgetting the basement, for indication of possible foundation problems, uneven settlements, etc. In case the

need for emergency interventions is indicated by the rapid inspection, it is obvious that all required action has to be completed before the detailed inspections are carried out.

7. Emergency interventions

The rapid (and the detailed) inspection of a building provides information about hazardous conditions requiring urgent intervention. The information about the required action and an engineering assessment of its urgency (low, medium, high) is recorded on the EDIF. The interventions aim either at saving buildings from collapse through emergency supports (bracing, shoring) or

DANGEROUS FOR USE

ADDRESS	SECTION No
DATE OF INSPECTION	TIME:.....
CREW No	REPORT No.....
INSPECTION TEAM DATA	
1. Name/ Title	Signature
2. Name / Title	Signature

Danger of partial or total collapse of the building and serious danger of injury or death. Entry is prohibited. Safety measures stated herein have to be taken immediately. Detailed inspection will follow.

(This posting does not necessarily imply demolition of the building).

<u>TYPE OF INSPECTION</u>	
RAPID (1 st) ☐	DETAILED (2 nd) ☐
URGENT RE-INSPECTION DUE TO POSSIBLE COLLAPSE ☐	
<u>SAFETY MEASURES TO BE TAKEN</u>	
URGENT SUPPORT REQUIRED ☐	
THE FOLLOWING ELEMENTS SHOULD BE DEMOLISHED OR REMOVED	
.....	
THE FOLLOWING UTILITIES MUST BE DISCONNECTED:	
ELECTRICITY ☐	WATER ☐ GAS ☐
OTHER:	

**DO NOT REMOVE THIS PLACARD UNTIL PERMISSION IS GIVEN BY
LOCAL AUTHORITIES**

Fig. 2. (Continued)

at removing some local hazards, e.g. a badly damaged chimney or parapet, or even at demolishing and removing debris from partially or totally collapsed buildings. In the field office where the inspection forms are fed into PEADAB a daily program for hazard removal and emergency support is prepared, taking into account the data for the buildings inspected the previous day (type of required action and urgency) and the progress of the intervention work by the various crews. The work scheduling will also consider any requests made by owners of damaged buildings.

The necessary intervention works require availability of material and equipment and should be carried out by specialised crews under the direction of an experienced

structural engineer. The intervention crews are also provided with the Emergency Intervention Form (Fig. 3) on which the available data from the inspection, rapid or detailed, appear and the progress or completion of the required work will be recorded for subsequent input into the PEADAB system.

8. Operational plan

An essential element for the success of the operation is its organisational structure. Based on experience gained from earthquakes in Greece during the past 30 years, the structure shown in Fig. 4 is recommended [2]. It is suitable for small- as well as large-scale operations, and if it

LOCAL AUTHORITY..... Crew No:
 OFFICE..... Report No:
 TEL.....

EMERGENCY INTERVENTION FORM

A. BUILDING LOCATION AND ID

Street..... No. Postal Code..... Town/Municipality
 Section No: Block No: Or Streets surrounding block: 1.....
 2..... 3..... 4..... 5.....
 Position of building in block: ☐ 1=Free 2=Middle (2 opposite sides free) 3=Corner (2 or 3 sides free)

C. DAMAGE (a) SEVERITY (1st BOX): 1 = None 2 = Slight 3 = Moderate - Heavy 4 = Severe -Total (b) EXTENT (2nd BOX): 1 = None 2 = 1 to Few 3 = Few to several 4 = Several to many

COLUMNS ☐ ☐ SHEAR WALLS/ ELEV. SHAFT ☐ ☐ FRAME JOINTS ☐ ☐ BEAMS ☐ ☐
 STAIRS ☐ ☐ BEARING WALLS ☐ ☐ INFILL WALLS (masonry, ecc) ☐ ☐
 ROOF ☐ CHIMNEYS, PARAPETS ☐ ☐ BUILDING OUT OF PLUMB ☐ ☐

Apparent ground problems: ☐ 1 = None 2 = Settlement 3 = Liquefaction 4 = Slope movement
 5 = Ground fissures 6 = Rockfalls 7 = Other (explain)

Indirect damage: ☐ 1 = None 2 = Pounding to adjacent building 3 = Fire 4 = Other (explain)

Inspected: Exterior ☐ Ground story ☐ 1st story ☐ Other stories ☐

D. OVERALL ASSESSMENT FOR USE (See back page for explanations):

Safe for use (GREEN) ☐ Unsafe for use (YELLOW) ☐ Dangerous for use (RED) ☐

The assessment made is : for the whole building: ☐ for part of the building: ☐

F. ACTION TAKEN: ☐ 1 = None* 2 = Local hazards removed* 3 = Urgent support provided 4 = Combination of actions 2 and 3 5 = Urgent re-inspection due to possible collapse

* Explain

** The following elements have been demolished or removed

Access to the following areas has been prohibited and blocked

The following utilities were disconnected: electricity ☐ water ☐ gas ☐

COMPLETION OF REQUIRED WORKS: ☐ 1= YES 2= NO

NEED FOR UNINTERRUPTED COMPLETION: ☐ 1= YES 2= NO

COMMENTS:

DATA: (1) HEAD OF INTERVENTION CREW (2) INSPECTION ENGINEER

1. Signature..... 2. Signature

Name/ Title..... Name/ Title.....

INTERVENTION FORM RECEIVED BY: Owner ☐ Building manager ☐ Other ☐

Recipient's Signature Name Date

Fig. 3. Emergency intervention form.

is properly prepared within the general pre-disaster planning it will produce the desirable results. In the tree depicting the organisational structure, each rectangle represents a certain domain of responsibility for which the personnel are selected from respective lists of available qualified people. The criteria for the selection of personnel for each assignment as well as the relevant responsibilities are presented in detail in Appendix A. The materials and equipment required for the operation are listed in Appendix B.

The computer program PEADAB, briefly described in Appendix C, will be quite useful in all phases of the operation (planning, setting-up, execution and data retrieval).

The emergency inspections operation will be part of a more general preparedness plan designed to deal with the state of emergency created by the earthquake. Therefore, the details of its implementation will depend upon this general plan and thus could vary from country to country. However, its main elements would not need

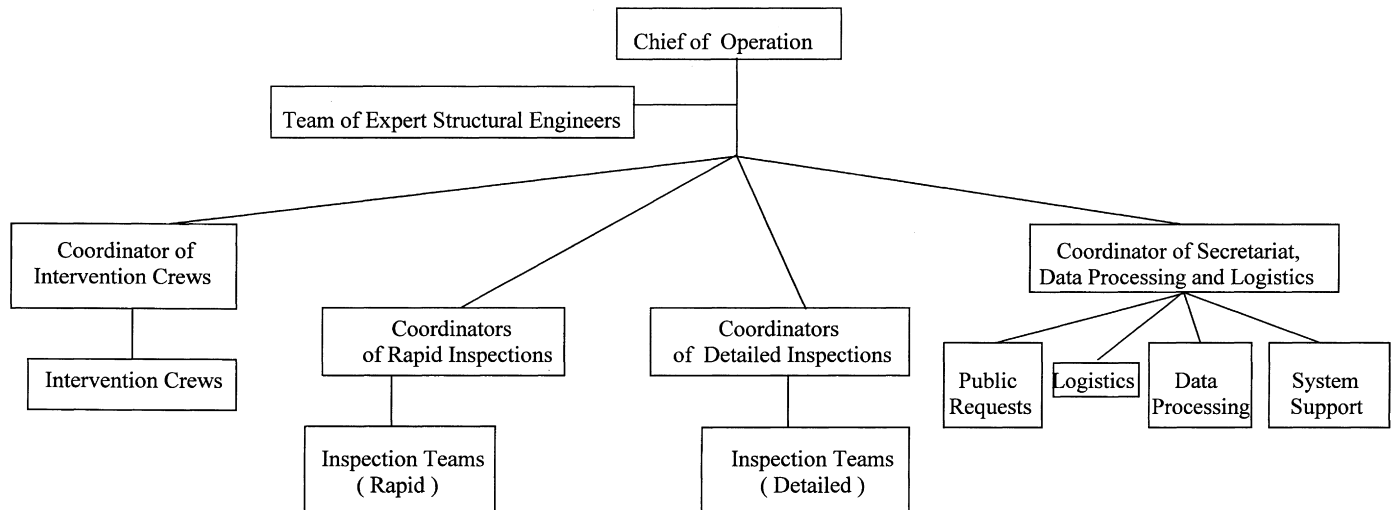


Fig. 4. Organisational structure for a large-scale emergency damage inspection operation.

to change, if the underlying inspection procedures remain the same.

9. Field safety of inspectors

The inspectors assessing the safety of a building damaged by an earthquake must be careful not to expose themselves to hazardous conditions. Quite often, a building that has suffered serious but not always readily observable structural damage from the main shock, may be in danger of collapse in the event of an aftershock. Therefore the basic safety rule inspectors must always observe, and which must always be emphasised, is not to enter a building unless they feel it safe to do so. This requires a careful survey of the building's exterior for a gross assessment of its safety condition. In addition, several other precautions as explained below should be taken.

Inspectors should work in pairs, not only for the purpose of reaching more reliable assessments by exchanging views, but also for enabling either member of the team to offer or call for help if the need arises. When entering a damaged building, inspectors must wear their hard hats and be in constant alert for aftershocks, falling hazards (parapets, glazing, appendages, ornamentation, etc.) or leaks of hazardous substances. In case of a factory, laboratory or storage area, they should be alert to possible release of hazardous material, either from sighting damaged containers and spills, or by odour, eye irritation, breathing problems, etc. In such cases, the inspectors should leave the suspected area and immediately inform the field office. Damaged utility installations may also constitute serious hazards, e.g. exposed electrical wiring or gas leaks. Gas can usually be detected by odour and an effort should be made to locate and shut off the main valve. Obviously, the inspectors should refrain from smoking when entering such premises and it is prudent to do so also when entering any damaged building.

10. Legal issues

At the stage of the emergency inspections operation planning (i.e., before a catastrophic earthquake strikes), the responsible authorities should take all necessary legislative steps to extend full insurance coverage to the personnel that will be involved in the inspections, for the duration of the operation. This may be done either by assigning to such personnel a temporary status of state or city employee for the period of the inspections or by instituting specific provisions. Under all circumstances, the inspectors should be free, by law, of any liability that may arise as a result of their assessment and posting or in general in the course of carrying out the inspections. This is a necessary measure to ensure objective assessments and avoid systematic conservatism by inspectors out of liability concerns in the event of damages that may result from posting decisions.

Emergency demolitions carried out during the operation require also well-instituted legal procedures because while some damaged buildings may constitute an obvious hazard and thus require immediate demolition, there will often be cases where the need for demolition could be debated. To avoid possible litigation it is necessary to have adequate legal procedures that will allow the demolition crews to act quickly, while at the same time securing all the rights of the property owners. Thus, buildings marked for demolition as being hazardous to the public should be reinspected by an expert team and the owner's consent should be sought before any action is taken. If the owner refuses to give his consent, he should be instructed to either remove the hazard on his own or face all the consequences for subsequent damages that may result from his hazardous property.

11. Concluding remarks

The procedures presented herein are based on experience accumulated in Greece as well as in other countries from

damaging earthquakes in the past 30 years and were developed with the goal to make them simple and hence as applicable as possible, under a wide range of conditions. Of crucial importance to the success of the operation are adequate planning as well as manning with well-trained personnel to be assigned to the task, especially concerning the members of the inspection teams and the intervention crews. Moreover, the computer system PEADAB that was developed to support the planning, setting-up and execution of the operation with its graphical capabilities to depict all types of data as the operation progresses constitutes a good tool that not only may induce authorities to plan such operations ahead of time but also will help to bring them to a successful completion.

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Appendix A. Human resources

The operation will be carried out mostly by people working for the city and local or state government. Volunteer structural engineers from the private sector may also be used as inspectors, if the available pool of structural engineers working for the public sector does not suffice. This will normally be the case if the earthquake strikes a major city. Under such circumstances, cooperation with engineering professional associations will help alleviate the problem. Referring to the organisational chart of the Emergency Inspections Operation (Fig. 4), the potential sources of the required personnel, its duties and responsibilities are described below.

A.1. Chief of operations

The person who will assume the post of operations chief should be a structural engineer official with the Building Department having jurisdiction over the affected area. Alternatively, and depending upon the administrative structure of each country, the chief of the operation could be a senior structural or civil engineering official of the city, the prefecture, etc. He should have a good leadership record, should be familiar with the problem and also quite knowledgeable of the emergency mobilisation plan and the bureaucratic machinery that will support the operation. He is selected by the emergency agency planners responsible

for the general mobilisation plan. His responsibilities are as follows:

- (i) Directs the setting up of the operation, i.e., secures personnel, assigns duties and sets up local field office.
- (ii) Specifies priorities, oversees work progress, chairs meetings with coordinators, approves/changes daily work program, decides on tasks for the team of experts, resolves conflicts, communicates with other emergency officials and authorities, replaces personnel if needed, gives pertinent information to the appropriate authorities and submits a final report.

A.2. Team of expert structural engineers

They should be senior structural engineers from the public or private sector, with expertise in earthquake engineering, damage assessment and strengthening. Their duties are: (1) to inspect buildings for which the opinion is divided as to the need for demolition, buildings of particular interest (e.g., public, industrial sites) and to suggest the appropriate structural support, and (2) to advise the chief of operation on technical issues and offer assistance to the coordinators of inspections and of intervention crews.

A.3. Coordinators of inspections (rapid or detailed)

The coordinators of the inspection teams should be experienced structural engineering officials of the city or the governmental agencies involved in the operation, familiar with the mobilisation plan and the bureaucracy of the agencies supporting the operation. The functions of coordinators of inspections are as follows:

1. Coordinate and supervise the work of 10–15 inspection teams.
2. Name the leader of each team.
3. Assign the areas of responsibility for each team.
4. Secure the availability of materials for the inspection teams.
5. Receive the damage inspection forms and rank the degree of urgency of the required actions.
6. Make spot checks of inspected buildings.
7. Give copies of the damage inspection forms for data processing.
8. Participate in the end-of-the-day meeting with the chief of operations and the coordinator of the support and demolition crews to prepare the intervention list for next day, review progress, solve problems, etc.
9. Resolve conflicts between their teams.
10. Seek the assistance of the team of experts if the need arises.

A.4. Coordinator of emergency support and demolition crews

The coordinator of the emergency support teams should be a structural engineer experienced in repair and

strengthening works, preferably an official of the city or the governmental agencies involved in this operation. The functions of coordinator of emergency support and demolitions are as follows:

1. Coordinates, directs and supervises the work of the emergency support and demolition crews.
2. Names the leader of each crew.
3. Assigns the work to the crews.
4. Secures the availability of tools, equipment and material for his crews.
5. Provides technical guidance and advise and inspects the work of his crews in the field.
6. Resolves conflicts between the crews.
7. In consultation with the chief of operations seeks additional technical assistance if his crews are not sufficient.
8. Seeks the technical advice of the team of experts in difficult situations.
9. Receives the Emergency Intervention Forms and checks the interventions that have been completed.
10. Gives the daily list for interventions as well as progress information to the data processing unit.
11. Participates in the end-of-the-day meeting with the chief of operations and the inspection team coordinators to prepare the intervention list for next day, reviews progress, solves problems, etc.

A.5. Damage inspectors

Damage inspectors constitute the backbone of the operation. They should work in teams of two inspectors one of whom will be the leader of the team. They should be structural engineers or architects, employees of the city or local government in the affected area, neighbouring jurisdictions or from other areas in the country having pertinent experience from past earthquakes. If their numbers are insufficient, local volunteer professionals could also be commissioned and utilised, with the assistance of the appropriate professional associations.

The person chosen as leader should be working preferably for the public sector, with previous experience in the assessment of earthquake damage and, in case of detailed inspections, should preferably be a structural engineer. The functions of damage inspectors are as follows:

1. Inspect the buildings, fill the damage inspection forms, barricade unsafe areas, mark them and post the buildings with the appropriate placard.
2. Explain to the building occupants the objectives of the inspection and the meaning of the posting. Make clear that this inspection has nothing to do with the detailed engineering evaluation and design that will be required to receive any governmental assistance for possible repairs.
3. The members of the team sign the posting placard and the damage inspection form. In case of disagreement

between the members of the team, the opinion of the leader prevails.

A.6. Emergency support and demolition crews

They should be structural works technicians, equipment operators and construction workers. They should come from the agencies involved in this operation (e.g., building departments, city technical services, public works department, etc.) or, if not sufficient in number, from the private sector.

A.7. Coordinator of secretariat, data processing and logistics

A public employee, preferably a section head, knowledgeable of the administrative system. His/her duties are as follows:

1. Coordinates and supervises the personnel supporting the operation.
2. Is responsible for the distribution of the material to the inspection teams. Checks if some stock needs replacement.
3. Is responsible for the smooth function of data processing. If any problem arises, makes sure it is resolved by the system support as soon as possible.
4. Processes copies of the Damage Inspection Forms and the Emergency Intervention Forms of the day to the Data Processing and makes sure the data is fed into the system.
5. Files the processed original Damage Inspection and Emergency Intervention Forms and gives the summary reports of the buildings needing urgent intervention to the coordinator of the intervention crews.
6. Groups the requests from the public and handles them to the appropriate sectors, i.e. coordinator of intervention crews, coordinator of inspections, or team of experts.

A.8. Data processing, secretariat and logistics, system support and public requests

The support personnel come from the departments or agencies to which the chief of operations or the coordinators belong, or from any other department, as foreseen in the emergency mobilisation plan. The functions of the support personnel are as follows:

1. Process the data on the Damage Inspection Forms.
2. Produce lists with requirements for further action.
3. Process the data of the Emergency Intervention Forms.
4. Produce summary reports.
5. Provide clerical and secretarial support to the operation.
6. Maintain stock and supply the materials required for the operation (see list), except for the materials needed for emergency support and demolition.

7. Support the smooth operation of PEADAB.
8. Handle requests by the public (e.g., provide inspection scheduling information, receive and process information about emergency conditions, explain safety classification, give information about government assistance for repairs, etc.).

Appendix B. Materials and equipment

The planning of the Post-Earthquake Emergency Inspections Operation should include the advance preparation and stocking of essential items. In addition, the availability of demolition equipment should be secured, as well as its operators. The following should be readily available for running the operation smoothly.

B.1. Equipment for the local field office

Equipment for a functional field office includes desks and chairs, telephones, photocopying machine, PCs, printers, as well, topographic maps of the community on a scale 1:10000 or 1:5000, and also 1:1000 showing street names, block numbers and, if possible, building ID numbers.

In addition, an adequate stock of items is required for the inspection teams.

B.2. Equipment of the inspection teams

1. Topographic maps (1:1000) with block and building numbers.
2. Field Manual.
3. Inspection forms and posting placards.
4. Pen and a notebook.
5. Measuring tape.
6. Carpenters' axe or hammer.
7. Flashlight.
8. Sprays with green, yellow and red paint.
9. Barricading tape.
10. Hard hat.
11. Official identification.
12. Digital camera.
13. Optional, binoculars.

B.3. Equipment for the hazard removal and demolition crews

The above will be provided by the city or local government technical services, or other pertinent departments. If the available equipment (bulldozers, cranes, etc.) from the public sector is not sufficient, it could be supplemented from the private sector. For operational efficiency this should be provided for in the general mobilisation plan in which updated lists of the required equipment, its owners and operators should be included.

Appendix C. The PEADAB system

Based on earlier work [9], a computer program abbreviated PEADAB has been developed [2–4] and is intended to be an easy-to-use tool for supporting operations of post-earthquake emergency assessments of building safety in earthquake-affected areas. It can help establish standard procedures necessary for the success of such operations that are often executed under chaotic conditions. Furthermore, it conserves the experience gained, as it is otherwise typically lost. The PEADAB system may be used in three modes:

- To support the planning of the post-earthquake emergency inspections operation by storing the available resources (human and material), which will be needed to set up the operation after the earthquake strikes (changes in the planning may be introduced also during the execution of the operation).
- To support the execution of the operation by processing the data of the inspection and intervention forms, checking the agreement of the recorded damage with the given posting (colour) classification, and by providing reports on various aspects of the operation in progress.
- To provide information concerning the progress of the operation, inclusive of daily lists of the buildings requiring emergency intervention.

The basic functions of PEADAB are presented in the following sections.

C.1. Plan operation

- (a) Definition of agencies: the name, address and information of the agencies that are going to participate in the operation are given.
- (b) Definition of available resources from each agency: the human and/or material resources contributed by each agency are introduced.
 - Personnel (engineers, technical staff, support stuff).
 - Vehicles, equipment (car, bulldozer, etc.).
 - Materials (e.g., equipment for the inspection teams, intervention crews, field office).
- (c) Selection of personnel and equipment for the operation.
 - Personnel: a box is chosen from the organisational tree (Fig. 4) and personnel for this position are selected from the available resources of the desired agency.
 - Equipment, vehicles, materials: these are selected from the list of agencies and are charged to the inspection teams or the crews for emergency interventions.
- (d) Division of the area into sections and assignment to coordinators.
 - The assignment may be accomplished in the program either by selection from a map, or by specifying the surrounding streets.

Extract Information

LISTS

List Name: List9

Description: Corner, Reinforced concrete cast in place, Number of stories>5, Year of construction between 1960-1984

QUERIES

Query Variables

1. Street
2. No
3. Postal code
4. Block no
5. Position of building in block (1=Free 2=Middle 3=Corner)
6. Number of stories
7. Number of apartments
8. Area of storey
9. Year of construction
10. Type of structural system
11. Usage of ground storey
12. Usage of stories
13. Soft or weak storey
14. Irregularity

Existing Values

1961
1965
1967
1968
1970
1972
1974
1976
1977
1978
1980
1984
1985
1990
1999

Value: 1984

(POSITION OF BUILDING IN BLOCK=3) AND (TYPE OF STRUCTURAL SYSTEM=20) AND (NUMBER OF STORIES>5) AND (YEAR OF CONSTRUCTION>1960) AND (YEAR OF CONSTRUCTION<1984)

Add this variable to List

Clear List

Save View report Histogram View map Close

Fig. 5. PEADAB screen for the selection of attributes defined by the user.

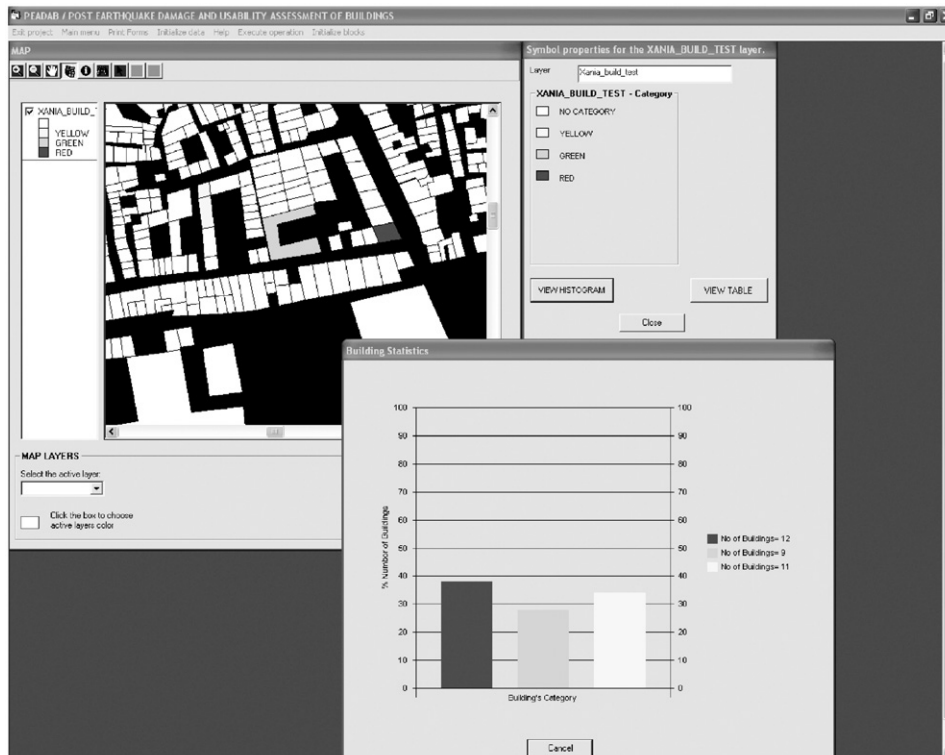


Fig. 6. Map and histogram of PEADAB depicting the results of the query.

C.2. Review/update operation

Update of the available resources (i.e. personnel, equipment, materials) may be performed at any time preceding or after the earthquake.

C.3. Execute operation

The data supplied by the inspection teams and the intervention crews for a specific building are introduced to the system either by selecting the building on the map, or by giving the address of the building.

C.4. View–extract information

PEADAB will provide the necessary information for the running of the operation, as well as overall information related to the recorded damage. In more detail

- (a) It provides lists of the following:
 - The personnel and equipment involved in the operation, and that kept in reserve and still available at each agency.
 - Buildings inspected and displayed by inspection team, by section, assessment for use, etc.
 - Buildings requiring emergency intervention shown by category of intervention and/or by degree of urgency.
- (b) It maps the inspected buildings according to their posting classification as the operation progresses.
- (c) It provides information on buildings for any combination of user-defined attributes recorded in the EDIF. For example: the damage distribution of all corner R.C. buildings built in the interval 1960–84 (years of code changes in Greece) and having over five storeys (Fig. 5). The information is produced either in list or histogram form, or depicted on a map (Fig. 6).

References

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