AN EMERGENCY TECHNICAL OPERATION HANDBOOK FOR CIVIL PROTECTION OPERATIVE CENTERS BORN OF THE ITALIAN EXPERIENCE IN UMBRIA MARCHE AND POLLINO EARTHQUAKES

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SUMMARY

Technical activities, performed since very first moment after Umbria and Marche earthquake, September 1997, were founded, most of all, on GNDT and SSN technicians and researchers experience of previous quakes. The acquired know-how allowed to design procedures and technical tools mainly to perform a complete damage survey and safety assessment on buildings, both public (strategic) and private (residential). Churches survey was another goal, because the vulnerability and cultural worth of a very large number of this kind of constructions, most of all ancient, and because the people needs of prompt solace and gathering place. Technical tools, tested during the quake, show a good performance and a lot of data, collected on about 120.000 buildings, will help to improve the know-how in several applied research field. The experience was useful especially to improve the *GNDT - SSN vulnerability and safety assessment form* herself, barely ready for use in September 97.The improved tools and procedures allowed the *SSN Emergency Office* to promote a - ready for use – Operative Center *Emergency technical operation handbook*, made with the *GNDT – L'Aquila Researchers Team* usual sharing. Other forms yet in use for historical towns, hospitals functionality and landslide survey (last one product by Italian Geological Survey and National Research Council) were added in the Book. It, eventually, offers a set of advises to perform the survey in order of priority and coordination with the Operative Center other emergency function teams and authority. The *Emergency operation handbook*, in his first version, was used and further tested, a year later, during the September 1998 Pollino (Southern Italy) earthquake and in a new improved version it will eventually be the official Italian civil protection operational book for damage survey. Last but not least, the systematization of emergency operation will let national and local government to plan a better reconstruction intervention, assessing financial needs and defining design guidelines.

INTRODUCTION

Every post-earthquake situation, besides having its specific features according to the features of the event in terms of severity and territorial extension, has had, until Umbria and Marche earthquake, one of its individual characteristics which also depends on "local conditions", that is to say from the particular training and organization of the various bodies involve, from the number and quality of the people involved as concerns their previous post-earthquake experiences or as previsional and preventional activities managed during seismic peace time. Hence it follows the necessity to define unified procedures to which, in future, everyone has to conform because all post-quake activities, from their first emergency and emergency phase, to the reconstruction phase, are all strictly tied and can't be considered in isolation. All that is set out and carried out at the very beginning will condition all the following phases.

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The morning of September 26, 1997, SSN and GNDT experts were called up to support the National Civil Protection Department for most part of the technical operations due Umbria - Marche earthquake.

The impressive amount of buildings collapsed or damaged, caused a need of shelter for a thousand of citiy and village residents and worried the civil protection authorities because of the danger due to unsafe constructions. The authorities decided a complete damage survey in order to provide safety operations and called up SSN and GNDT teams to support the survey campaign. While the professional qualification and the main survey tools were available, the Operative Centers suffered because of the large amount of operations to solve and some lack of procedures. At the end of a four-month-damage-survey and safety assessment involving hundreds of technicians in about 120.000 construction safety evaluation, the participant experts decided to draw an Operative Handbook in order to collect all the material used and to define the main operations for the future. Actually the operative model was used and tested, a year later, on the 9th September 1998 earthquake in the Pollino area (Southern Italy).

General design

The general idea was to define a "field operative route", starting from the citizen survey request coming through the city major into the Operative Center. The major organizes people requests in three different files (residential houses, strategic buildings and churches), taking part in priority decisions and passing the requests to the Operative Center, where the survey manager sends a technicians' team to assess the damage, eventually informing the major about situation and the needs for safety. The major plays a basic role in the operations flow, because he only (or his office) can collect different requests coming from residents in the same building, he can assure access for the survey teams, he eventually can decide the evacuation also providing provisional operations to assure safety. The construction were divided in three different typologies because strategic buildings needs the best priority and, often, specific experts' teams (e.g. hospitals). Churches are a very widespread typology. Often ancient constructions with a historical, artistic and architectural peculiarity, also need special teams of experts. Besides, after an earthquake, people ask for churches because of their traditional role in the village as gathering and comforting place. Further, damaged buildings often threaten routes or other lifelines and so do landslides. Therefore other two "field operative routes" were designed, in order to assess these problems using composite teams of different professional fields experts.

Equipment and human resource

The Umbria Marche quake allowed to define resource and, after that, the Pollino quake confirmed the evaluation. The Operative Center layout, the equipment, the human resource were assessed. The operations need space to accommodate the managing group, to receive, train, sort and send teams, allowing meetings, etc… in different rooms, without any interference, considering the pressure situation in which operations are carried out. The managing group needs four/five people to manage about 400 survey a day. A non-trained person can input an average number of 60 survey forms each day or 100 request/team/survey result operations a day (from 50 to 100%less than the trained person). Teams perform (each team) survey assessment from 1 to 20 a day, training and assignment included, depending on the situation (experience, difficulties in survey, building complexity, or in finding address, in weather condition, in transport or others), on an average of 6/7 a day. Computers, copiers, faxes, modems, phones and other equipment needs are assessed. The request trend starts slowly with a massive climb after three/five days. During the first days is necessary to have a few well trained teams disposal, usually called up from different Regional and National Civil protection offices or from SSN and GNDT, to provide worst situations. After, when the request trend shows first increasing a general call up is needed, using both private professionals and civil service experts.

The technical tools

The Handbook collected a several different form created in order to perform survey. The most important (hardly ready in September 1997) is the damage and safety assessment form designed by SSN and GNDT. The first level form for damage evaluation, quick intervention and safety of buildings in a seismic emergency, is one of the tools being studied by a working group consisting of the GNDT and SSN. This working group was formed with the aim of inspecting and updating the approaches and procedures concerning general data collection for the damage study and the evaluation of the seismic vulnerability of buildings, regarding all forms of construction but particularly those in masonry. The work for the determination of a survey and safety evaluation form was still in progress when an earthquake struck the border area between Marche and Umbria and therefore was used in a real situation. In the days immediately following those of the two main tremors, the form was adopted by the National Department for Civil Protection and was also used by the fire department in an experimental way for

the damage survey and safety evaluation in the Marche region. In the setup of the new form, the authors tried to maintain the conceptual approach of an instrument (AMADEUS) [Gavarini, 1985] elaborated some years ago within the GNDT, that had identified the basic contents and proposed a logical-decisional model to be followed in the process of safety evaluation after an earthquake. Damage and safety assessment are:

- management instruments as regards some emergency aspects with particular reference to building safety and to the amount of people evacuated and the consequent needs of temporary shelter structures;
- instruments for the definition of damages and then of the necessary resources for restoration interventions;
- instruments for the setting out of reconstruction activities

The form is divided into sections: in section 1 there is the identification of the building (this occupies all the top part, then there is a space in which all the cartographic identifications are written on a plan). In section 2, the description of the building is reported; in section 3, the type; in section 4, there is the description of damage to structural elements and the most urgent interventions carried out; in section 5, damage to non-structural elements and, here too, the most urgent interventions carried out; in section 6 the external damage and in section 7 the geological-geotechnical situation. In section 8 there is the definition of risk levels: structural and non-structural, external and geotechnical with three evaluation possibilities: high, low with measures and low. This section constitutes a type of evaluation synthesis of the risk situation and through this synthesis the next phase is then directed towards results regarding safety. This phase is subdivided into five possibilities: safe building (A), safe building with intervention measures (B), partially unsafe (C), temporarily unsafe, to be re-examined carefully (D), and unsafe building (E). Section 9 is intended for notes that can be freely and opportunely expressed by the surveyor and that may prove very useful in clarifying specific situations. To fulfil the simplicity and rapidity requirements, data which are directly observed or easily available, have been included in the form; information which is nevertheless sufficient to give a minimum description of the building and is useful for various reasons after an earthquake. One of the first requirements is the identification of the building. This is a basic operation in this type of survey, however it requires particular attention in its organization so as to be easily feasible. Concerning the seismic risk of the construction, the building is basically a structural unity, eventually interacting with other adjacent units, to be considered in the safety evaluation. Since it is often difficult to identify this structural unity in historical towns, where buildings constructed in different periods and with different materials are inter-connected and grouped along streets and squares, the manual for the form compilation suggests some criteria, taking into account homogeneity in construction type and geometry (e.g. number of storeys). For easy use, the form adopts a filling-in system with choices on pre-classified information and with the possibility of multi-choice in some cases.

The form has been conceived and realized as a concise tool for easy data collection, concerning the structural and non-structural evaluation, for a typological and vulnerability judgement of the building and also to act as a guide in the safety evaluation. In the determination of type, and in particular of damage, the authors have tried to establish a comparative classification in terms of the European Macroseismic Scale [Grunthal 1993]. This allows for a conversion of the collected data to the scale and therefore, to progressively illustrate the macro-seismic picture with a more marked engineering characterization. The data can also be used for the approximate estimation of the costs necessary in order to activate intervention policies. This type of utilization has been tested through the establishment of an evaluation model for economic damage. The form has also been experimented through the realization of software, converting the data collected, within the form, into corresponding information from the GNDT first level masonry form rendering existing costs models utilizable [Angeletti, 1984; Benedetti & Petrini, 1984]. The conversion has provided the first cost estimates, which have been made available to the National Department for Civil Protection. The information has proved useful to the local authorities, who are currently involved in the organizational phase for the repair and restoration interventions. A new version of the form, recently produced by the working group, is presented in Appendix 1. Other forms are contained: a Churches, Landslides, etc.. and a different managing sheets useful for follow the different field routes regarding the operations (Appendix 2). A Excel simple tool is enclosed, now implementing in a better visual basic tool, in order to insert it in a wide computer tool address to manage all emergency functions.

CONCLUSIONS

Now that a first complete and computerized version of the Emergency Handbook has been defined, the National Department of Civil Protection has started up Regions and with all the Bodies and Institutions involved, in order to arrange and definitively approve these standardized procedures. Besides, consequent training and informative activities at all levels are being programmed, so that in the event of future seismic events all the people involved in the emergency could be ready to face them using pre-defined procedures and by using a common language, assuming in this way a greater timeliness and efficiency.

APPENDIX 1

Presidenza del Consiglio dei Ministri
DIPARTIMENTO DEI SERVIZI
TECNICI NAZIONALI

Presidenza del Consiglio dei Ministri
DIPARTIMENTO NAZIONALE DELLA PROTEZIONE CIVILE

Consiglio Nazionale delle Ricerche
GRUPPO NAZIONALE PER LA
DIFESA DAI TERREMOTI

1sh LEVEL FORM FOR DAMAGE EVALUATION, QUICK INTERVENTIONS AN USABILITY OF BUILDINGS IN THE SEISMIC EMERGENCY

(Ver. 09/98)

SECTION 1 Building identification

Surveyor |__|__| Form |__|__|__|__|__| Date |__|__| |__|__| |__|__|

Provincia: _______________________________________

Township: _______________________________________

Locality: _______________________________________

Istat Reg. |__|__| Istat Prov. |__|__|__| Istat Comune |__|__|__| N. aggregate |__|__|__|__|__| N. building |__|__|__|__|__|

Address

1 ❍ street |__|__|__|__|__|__|__|__|__|__|__|__|__|__|
2 ❍ road
3 ❍ alley |__|__|__|__|__|__|__|__|__|__|__|__|__|__|
4 ❍ square
5 ❍ locality Number |__|__|__|__|

Position

1 ❍ Isolated
2 ❍ Internal
3 ❍ End
4 ❍ Corner

Istat Codes Locality Code |__|__|__|__|__|__|

Census section |__|__|__|

Ref. In map N. carta |__|__|__|__|__|__|__|

Land register: Foglio |__|__|__|__| Mappale |__|__|__|__|

Particelle |__|__|__|__|__| |__|__|__|__|__|

Building name or owner of building |__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|

Use code |S |__|__|

Photocopy of structural aggregate with building location and identification code

SECTION 2 Building description

Metrical data					Age	Use			
Total number of stories(1)		**Average story height** [m]	**Average floor area** [m²]		**of building and strengthening**	**Use**	**Number of units in use**	**Utilisation percentage**	**Occupants**
❍ 1	❍ 9	1 ❍ ≤2.50	A ❍ ≤50	I ❍ 1300÷2100	1 ❑ ≤1919	A ❑ Living area	1 ❍ 1 ÷ 2	A ❍ > 65%	1 ❍ no one
❍ 2	❍ 10	2 ❍ 2.50÷3.50	B ❍ 50 ÷80	L ❍ 2100÷3300	2 ❑ 19 ÷45	B ❑ Production	2 ❍ 3 ÷ 5	B ❍ 30÷65%	2 ❍ ≤10
❍ 3	❍ 11	3 ❍ 3.50÷5.0	C ❍ 80 ÷130	M ❍ 3300÷5000	3 ❑ 46 ÷60	C ❑ Business	3 ❍ 6 ÷ 9	C ❍ < 30%	3 ❍ 11÷20
❍ 4	❍ 12	4 ❍ > 5.0	D ❍ 130 ÷210	N ❍ 5000÷8000	4 ❑ 61 ÷71	D ❑ Offices	4 ❍ 10 ÷15	D ❍ Not utilis.	4 ❍ 21÷40
❍ 5	❍>12		E ❍ 210 ÷330	O ❍ 8000÷10000	5 ❑ 72 ÷81	E ❑ Pub. Serv.	5 ❍ 15÷24	E ❍ In costruc.	5 ❍ 41 ÷80
❍ 6		**Basement floor**	F ❍ 330 ÷500	P ❍ > 10000	6 ❑ 82 ÷91	F ❑ Storage	6 ❍ > 24	F ❍ Unfinished	6 ❍ 81 ÷160
❍ 7		A ❍ 0 C ❍ 2	G ❍ 500 ÷800		7 ❑ > 91	G ❑ Strategical		G ❍ Abandoned	7 ❍ ≥160
❍ 8		B ❍ 1 D ❍ ≥3	H ❍ 800÷1300				**Ownership**	A ❍ Public	B ❍ Private

(1) - including underground levels

1st page

Istat Provincia _____	Istat Comune _____	Surveyor _____	N. of form _____	Date _____

SECTION 3 Typology (multi-choice with max 2 options)

Vertical structures / Horizontal structures	Non identified	MASONRY STRUCTURES: Irregular and bad quality masonry (Crushed stones, not squared, stones, pebbles,..) — Without tie-beams or stringc.	Irregular and bad quality masonry — With tie-beam or stringc.	Regular and good quality masonry (Bedstones,brick, squared stones,...) — Without tie-beams or stringc.	Regular and good quality masonry — With tie-beams or stringc.	Isolated columns	Mixed with r.c.
	A	B	C	D	E	F	G
Not identified	❍	❒	❒	❒	❒	SI	r.c. on masonry
Vault without tie-beams	❒	❒	❒	❒	❒	❍	❍
Vault with tie-beams	❒	❒	❒	❒	❒		masonry on r.c.
Truss with **deformable slabs** (wooden beam with single layer plank, girder and voults,...)	❒	❒	❒	❒	❒	NO	❍
Truss with **semirigd slabs** (wooden beams with double layer plank, girder and flat planks,...)	❒	❒	❒	❒	❒	❍	orizzont.
Truss with **rigid slabs** (R.c. slabls,...)	❒	❒	❒	❒	❒		❍

OTHER STRUCTURES	
R.C frame	❒
R.C. Walls	❒
Stell frame	❒

Regularity		Not regular	Regular
		A	B
1	Plan or elevation	❒	❒
2	curtain wall disposition	❒	❒

ROOFING
1 ❍ Pushing and heavy
2 ❍ Not pushing and heavy
3 ❍ Pushing and light
4 ❍ Not pushing and light

SECTION 4 Damage to STRUCTURAL ELEMENTS and provisional interventions already carried out

Structural - components Pre-exsisting damage / Level - extension	DAMAGE (1): D4-D5 Very serious > 2/3	D4-D5 Very serious 1/3 - 2/3	D4-D5 Very serious < 1/3	D2-D3 Serious > 2/3	D2-D3 Serious 1/3 - 2/3	D2-D3 Serious < 1/3	D1 Light > 2/3	D1 Light 1/3 - 2/3	D1 Light < 1/3	None	MEASURES TAKEN: None	Demolitions	Tie-beams	Restorations	Props	Barriers and passage protections
	A	B	C	D	E	F	G	H	I	L	A	B	D	F	H	L
1 Vertical structures	❒	❒	❒	❒	❒	❒	❒	❒	❒	❍	❍	❒	❒	❒	❒	❒
2 Horizontal structres	❒	❒	❒	❒	❒	❒	❒	❒	❒	❍	❍	❒	❒	❒	❒	❒
3 Stairs	❒	❒	❒	❒	❒	❒	❒	❒	❒	❍	❍	❒	❒	❒	❒	❒
4 Roofing	❒	❒	❒	❒	❒	❒	❒	❒	❒	❍	❍	❒	❒	❒	❒	❒
5 Curtain walls, partitions	❒	❒	❒	❒	❒	❒	❒	❒	❒	❍	❍	❒		❒	❒	❒
6 Pre-existing damage	❒	❒	❒	❒	❒	❒	❒	❒	❒	❍						

(1) - For each level provide the extent of damage only if present. If the object on the line is not dameged tick off **None.**

SECTION 5 Damages to NON STRUCTURAL ELEMENTS and provisional interventions already carried out

Type of damage / Interventions	DAMAGE PRESENT	MEASURES TAKEN: None	Removal	Props	Restoration	No-access	Barriers and passage protection
	A	B	C	E	G	I	L
1 Detachment of plaster, coverings, false ceilings	❍	❍	❒	❒	❒	❒	❒
2 Fall of roof tiles, chimneys...	❍	❍	❒	❒	❒	❒	❒
3 Fall of cornices, parapets,...	❍	❍	❒	❒	❒	❒	❒
4 Fall of other internal or external objects	❍	❍	❒	❒	❒	❒	❒
5 Damage to plumbing, sewage or heating systems	❍	❍			❒	❒	❒
6 Damage to electrical or gas system	❍	❍			❒	❒	❒

SECTION 6 External danger caused by other buildings and interventions already carried out

Tipe of damage / Interventions	DANGER ON: Building	Internal streets	Access	MEASURES TAKEN: No access	Barriers and passage protection
	A	B	C	D	E
1 From the collapse of other buildings	❑	❑	❑	❑	❑
2 From the fall of elements of other buildings	❑	❑	❑	❑	❑

SECTION 7 Land and foundation

MORPHOLOGY OF THE SITE	SETTLEMENTS OF SOIL OR FOUNDATION PRESENT OR POSSIBLE
1 ❍ Top 2 ❍ Strong slope 3 ❍ Slight slope 4 ❍ Horiontal	A ❍ Absent B ❍ Created by eqk C ❍ Increased by eqk D ❍ Pre-existing

2nd page

Istat Provincia |__|__|__|	Istat Comune |__|__|__|	Surveyor |__|__|	N. of form |__|__|__|__|__|	Date |__|__|__|__|__|__|

SECTION 8 Safety assessment

RISK ASSESSMENT

RISK	*STRUCTURAL (Sect. 3 e 4)*	*NON STRUCTURAL (Sect. 5)*	*EXTERNAL (Sect. 6)*	*GEOTECHNICAL (sect. 7)*
LOW	❍	❍	❍	❍
LOW WITH MEASURES	❍	❍	❍	
HIGH	❍	❍	❍	❍

SAFETY RESULT

A	**SAFE** building	❍
B	**SAFE WITH QUICK INTERVENTIONS** but temporarily not safe	❍
C	**PARTIALLY UNSAFE** building	❍
D	**TEMPORARILY UNSAFE** to be carefully reviewed	❍
E	**UNSAFE** building	❍

UNSAFE UNITS, FAMILY AND PEOPLE EVACUATED

N. of unsafe units |__|__| Families evacuated |__|__| N. of people |__|__|__|

LIMITED (*) OR EXTENSIVE (**) MEASURES TAKEN TO (CASE B)

*	**	MEASURES SUGGESTED	*	**	MEASURES SUGGESTED
1 ❐	❐	Application of reinforcement	7 ❐	❐	Removal of cornices, parapets, projecting elements
2 ❐	❐	Repairs of light damage of curtain wall and partitions	8 ❐	❐	Removal of internal and external objects
3 ❐	❐	Roofing restoration	9 ❐	❐	Barriers and passage protections
4 ❐	❐	Props on stairs	10 ❐	❐	Repairs to systems
5 ❐	❐	Removal of wallings, coverings, false ceilings	11 ❐	❐	
6 ❐	❐	Removal of tiles, chimneys, parapets	12 ❐	❐	

SECTION 9 Other observations

Inspection accuracy	1 ❍ Outside only	2 ❍ Partial	3 ❍ Complete (> 2/3)

On the damage, on interventions, on usability, etc.

Subject	*Notes*	Photograph	pin

SURVEYOR *(in block letters)*	***Signature***

3rd page

APPENDIX 2
FORM LIST ENCLOSED IN THE TECHNICAL OPERATION HANDBOOK

Form I1 - Petition to the Mayor about inspection public, private, monumental and religious buildings
Form I2 - Petition to the Mayor about inspection for landslide phenomenon
Form I3 - Petition to the Mayor about joined inspection

Form R1 - Request to Operative Center about inspection private buildings
Form R2 - Request to Operative Center about inspection public buildings
Form R3 - Request to Operative Center about inspection monumental and religious buildings
Form R4 - Request to Operative Center about inspection about landslide phenomena
Form R5 - Request to Operative Center about joined inspection

Form A1 - Surveyor private data
Form A2 - Technical Coordination Group member private data
Form A3 - Composition Operative Center Technical Coordination Group
Form A4 - Technical team composition
Form A5 - Identity card
Form A6 - Transit permission in areas devastated by a quake
Form A7 - Permission for practicability inspections
Form A8 - Vademecum for the teams involved in building practicability survey

Form S1 - First level form about damage first aid practicability survey for ordinary building
- Second level form both for masonry and concrete structure
Form S2 - First level form for building vulnerability survey
Form S3 – Form for churches seismic damages post quake emergency
Form S4 – Landslide phenomenon census paper
Form S5 – Joined survey statement

Form GP1 – Public, private, monumental, religious urgent measures
Form GP2 - Urgent landslide area measures

Form GE1 - Public, private, monumental, religious urgent safety account
Form GE2 – Account about landslide area inspections

Form G1 - Operative Center summary about council inspections – private buildings
Form G2 - Operative Center summary about council inspections – public buildings
Form G3 - Operative Center summary about council inspections – monumental and religious buildings
Form G4 - Operative Center summary about council inspections – landslide phenomena
Form G5 - Operative Center summary about council inspections – joined inspections
Form G6 – Daily summary about private building inspection activities
Form G7 - Daily summary about public building inspection activities
Form G8 - Daily summary about monumental and religious buildings inspection activities
Form G9 - Daily summary about landslide phenomenon inspection results
Form G10 – Daily statement scheme

Form GS1 – Inspection list about public buildings damaged by earthquake
Form GS1b – Special and strategic building list
Form GS2 - Inspection list about private buildings damaged by earthquake
Form GS3 - Inspection list about religious buildings damaged by earthquake
Form GS4 - Inspection list about landslide phenomena
Form GS5 – Joined inspection list

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