Chapter 23
KnowRISK Practical Guide for Mitigation of Seismic Risk Due to Non-structural Components

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Abstract Good performance of non-structural elements can be decisive in saving lives and costs when an earthquake strikes. The European project KnowRISK aims to educate and encourage households to take the necessary precautionary measures to protect people, houses, and contents. Preparedness and prevention act on community resilience. Within the KnowRISK project, the idea of a Practical Guide has been conceived suggesting seismic mitigation solutions for non-structural components to non-experts stakeholders. It is intended to guide people into the first steps of prevention in a straightforward manner, minimizing or avoiding injuries, damage, and long-term financial consequences. The novelty of the Guide belongs to his philosophy: a path through increasing challenges corresponds to a growing level of safety. The idea is that anyone can mitigate seismic risk in its own environment by adopting simple and low cost measures. The Practical Guide may contribute to increase risk awareness. This kind of initiatives if undertaken at larger scales may also enhance social resilience.

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23.1 Introduction

Traditionally, non-structural components are the architectural, mechanical and electrical components found in buildings, as well as exterior and interior elements that are not part of the structural system, which means they are not designed to transfer loads. Loss or failure of these elements can occur even when no structural failure is observed. This kind of damages can affect the safety of the occupants of the building and safety of others who are in its vicinity. Non-structural building elements may be easily retrofitted and, in most cases, at a low cost. Mitigation techniques can also be applied to reduce the damage.

However, the public is not adequately informed about the danger of non-structural failures and especially on how to fix non-structural components. To fill this knowledge gap, we designed a Practical Guide to be used as a reference by the public to locate, fix and avoid non-structural damages. This Practical Guide is being prepared based on the outputs of Task C (Non-structural seismic risk reduction) of the KnowRISK (2016) project, and takes into account the local culture and needs of each of the participating countries: Portugal, Italy and Iceland. Previous works developed by FEMA (FEMA 2012), Petal (2003) and Quake Safe Guide (Earthquake Commission 2012) were used in the first versions of this Practical Guide.

The Practical Guide addresses essentially non-structural issues found in our homes, whose solutions can be executed by the occupants themselves, with minimal skills at almost no cost. This is expected to encourage immediate public engagement into preparedness, by providing mitigation measures that can be carried out by anyone at anytime. However, more demanding retrofitting are also proposed: for these, seeking the help of a professional is recommended referring to a Portfolio, prepared in Task C.4 of the KnowRISK project, where suggestions that are more technical are collected and published.

The Practical Guide is intended to be a KnowRISK product for laypersons, standard for the three participant countries, and it uses images and symbols extensively, rather than text that would need to be translated into the different languages.

Because the public might non be favourable in undertaking the proactive actions suggested in the Guide, care has been devoted to find effective and persuasive message that are a good compromise between what they want to hear and what we want them to do. A greater safety of the living place is the main goal of the KnowRISK project, but this is achieved only if people are acquainted with the potential dangers of their living place. The learning is expected to be in steps, where the reader explores the guide several times before acting: first to realize how unsafe the own environment is, and then to follow the suggestions contained in the guide. The Practical Guide must then be handy and appealing for frequent use.

23.2 Layout and Contents

The main concern of the Practical Guide is to portrait common non-structural safety hazards in the home, as well as providing their solutions (Fig. 23.1). The chosen media format is a foldable brochure, an always-at-hand guide that can be distributed in strategic communication actions to reach the widest audience.

The solutions have been grouped into categories representing a four steps path, from passive interest to active engagement, and accomplish to a wide range of needs the public might have. These needs have been a matter of study by Task D (Going into target-communities) of the KnowRISK (2016) project and are in part discussed by Musacchio et al. (this volume). Each step has an associated colour that highlights to the level of risk and urgency: Red, Orange, Yellow and Green, in order of decreasing risk and urgency. These are the colours often used for weather warnings and resemble those of the traffic light; the public is already familiar with them and can intuitively estimate what level of risk is associated.

The display of the practical solutions occupies the central focus of the foldable guide. It is adaptable to different degrees of motivation, from passive interest to active engagement. A polyptych unfolds in the length of eight panels featuring a detailed description of the problems and solutions using symbols and images for various specifications. The four main categories, described in the next chapter, of the guide can be summarized in:

- Eminent danger,
- Material losses,
- Secure anchoring,
- Investment enhancements.

Fig. 23.1 Polyptych of the Practical Guide. The reader can follow a process to increase own safety from very simple actions, that may not increase significantly security, to more demanding measures. The "status" of safety is marked by the colors of the traffic light

The main target of the guide is to help the reader to locate vulnerable non-structural elements, and to find information on how to mitigate the potential risk of damage. However also additional support and institutional information are provided. In particular, the reader can find

- Initial front page,
- A brief introduction to the Practical Guide,
- An explanation of non-structural elements,
- A map of Hazard for each participating country,
- Space for complementary information,
- Acknowledgement and 'disclaimer'.

This part of the Practical Guide is intended to give a general view of the hazard of the place where the user lives, a general description of what to look for, useful information on how to know more about non-structural damages.

23.3 Practical Solutions and Categories

The Practical Guide helps in identifying viable non-structural loss mitigation techniques. It suggests measures that can be taken, not only at home but also in classrooms, offices, and public spaces. These suggestions are a collection of protective measures identified during the project or taken from guides and reports about earthquake safety worldwide. It also lists solutions specifically suitable for the local culture and needs of each of the participating countries.

Most of these solutions have been designed to make use of materials available at local hardware stores (Fig. 23.2), and tested in the shaking table at LNEC – Laboratório Nacional de Engenharia Civil, in Lisbon (Fig. 23.3). Details of the testing can be found in Candeias et al. (2017).

DIY (do it yourself) solutions with low cost are given preference, for example, moving heavy or large items to the floor or lower levels of shelves, properly hanging mirrors and pictures, installing latches on kitchen cabinets, etc. A detailed description of the problems and solutions is depicted by symbols and images.

One section of the instructions – What you need – is dedicated to materials and tools required, with a classification for the expected price and expertise.

Starting with immediate survival concerns, the solutions evolve from quick-fixing with zero cost (such as rearrange furniture and contents) and progressively increase in investment of time and financial expense, as well as responsibility, proactivity and knowledge. The solutions at the end of the categories path should reach the highest expertise and cost required, at which point an alert is given to consult an accredited professional and look for further detailed guidance in the Portfolio of solutions, from the KnowRISK project.

Fig. 23.2 Example of protective solutions tested on the shake table at the LNEC

Fig. 23.3 Left: prior the shaking table test with unsecured objects. Right: after the shaking table test

23.3.1 Category 1: Eminent Danger

This section contains the most basic and immediate issues that might interest even those less inclined to this learn about non-structural risk and mitigation possibilities. Simple solutions without spending money, such as moving objects to a better position to avoid injuries or block exits, are proposed (Fig. 23.4).

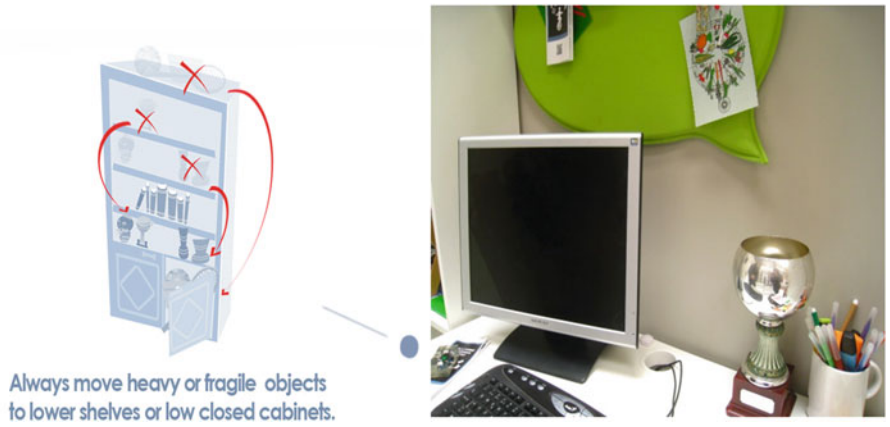

Fig. 23.4 Move heavy objects (like trophies) from higher to lower levels of shelves

23.3.2 Category 2: Material Losses

The next recommendation is to secure things that can cause injury, things that are of monetary and/or emotional value, and things which when damaged can impair continuity of educational/business activity. The goal is to prevent objects from falling or flying and enhance safety. Measures such as placing adhesive pads on valuable china, using non-slip mats, strapping screens are good and low cost solutions, for which the required material are available in several hardware stores (Figs. 23.5, 23.6 and 23.7).

23.3.3 Category 3: Secure Anchoring

This section includes measures that can increase the level of safety by taking additional measures, which require more investment and time. Fastening fans, chandeliers, flowerpots, frames, mirrors; securing tall furniture to the wall to avoid toppling (Figs. 23.8 and 23.9); protecting shelves with wires; using glazing film or close drapes on windows are some of the measures recommended.

23.3.4 Category 4: Interventions that Require a Professional

This category includes long-term investment solutions, with high cost and requires technical intervention. Replacing windows with safety glass (tempered), reinforcing

Fig. 23.5 Top: Example of flat screen safety strap. During the shake table tests the provided self-adhesive stopped being sticky after several attempts. Bottom: non-slip rubber mat to prevent objects from falling or flying

Fig. 23.6 Non-slip rubber mats can prevent movement of objects, but these should be used in dry surfaces. During the shake table tests, the fish bowl fell down due to the presence of water. Use of double-sided adhesive take is advised to secure fish bowls

chimneys and balconies, securing satellite dishes and solar power plates, improving gas pipelines and wiring, securing bunkbeds together (top & bottom) and anchoring them to a wall are some examples.

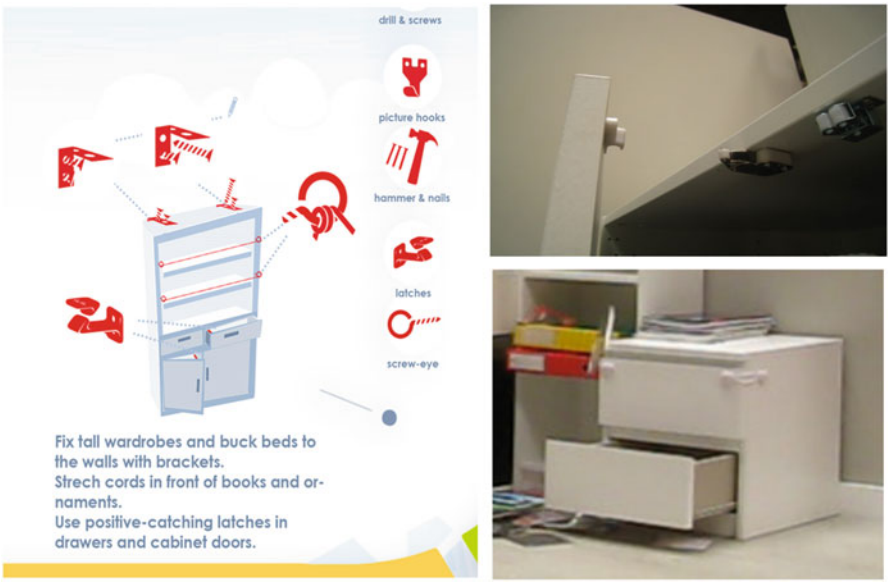

Fig. 23.7 Installation of latches on cabinet doors and drawers to keep them closed during an earthquake. The bottom picture shows the condition of drawers after the shaking table test

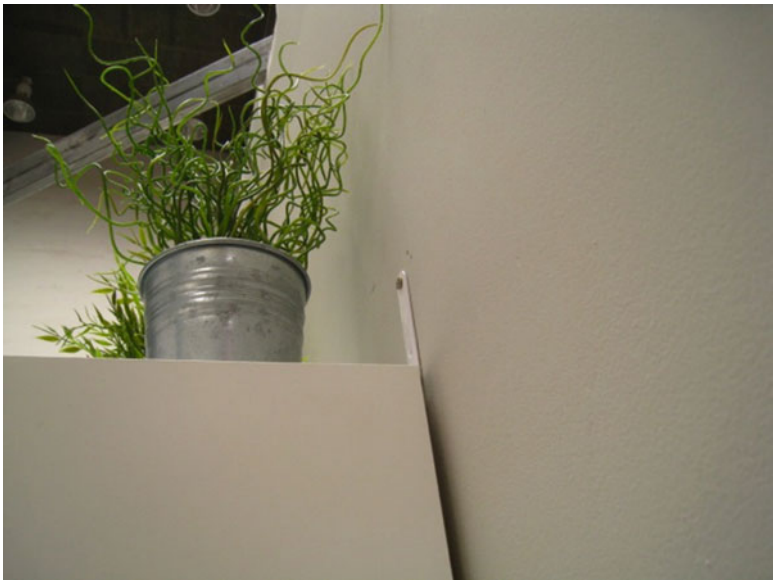

Fig. 23.8 Top-heavy furniture should be secured to a wall

Fig. 23.9 Condition of unsecured (left) and secured (right) after shaking table tests

23.4 Additional Information

The following information is also given:

23.4.1 Initial Front Page

It has a cover image that raises awareness to the connection between earthquakes and the contents of houses. (Fig. 23.10).

23.4.2 Introduction

This section includes a hazard map for each country (Fig. 23.11), designed specifically for the public, to help people become more aware of earthquake hazards across the country and the need for protection measures It also contains a general overview and explanation of the guide, as sequence of progressive solutions.

Fig. 23.10 Front page image

23.4.3 Acknowledgement and 'Disclaimer'

It has the logos of the institutions and the list of collaborators and sources.

The disclaimer warns the reader that the suggested solutions do not ensure full safety:

> This is just a Practical Guide. Individual situations may vary. Whenever necessary consult a specialist. You can find more information in the Portfolio.

Given the cultural differences of each country, that in turn reflect in different living styles and habitudes, the disclaimer is a necessary reminder.

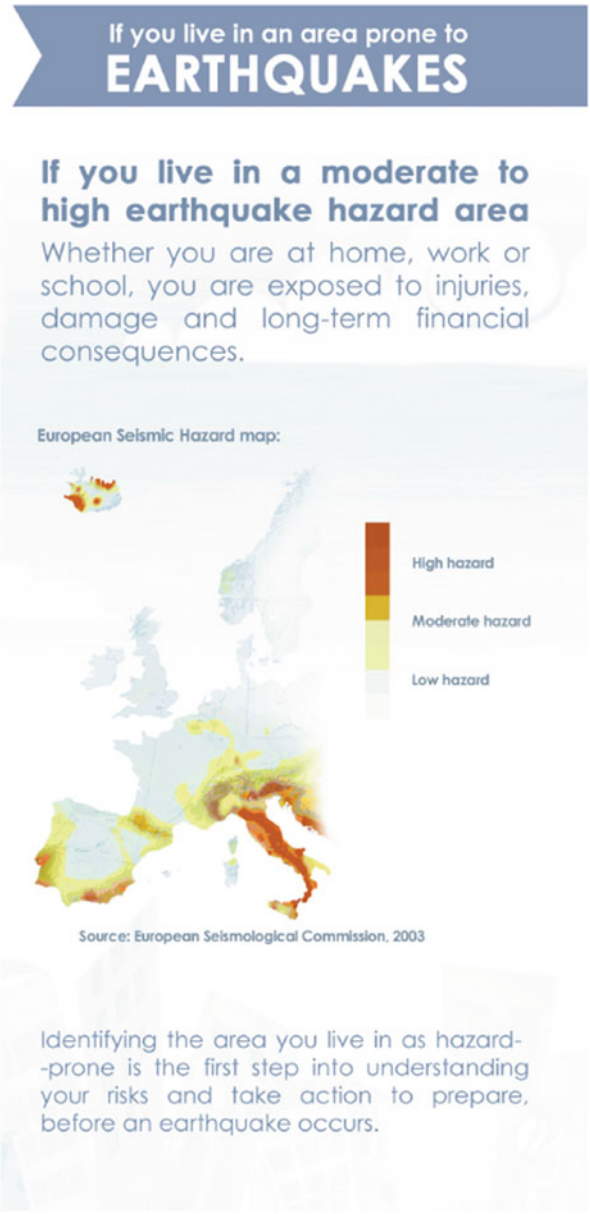

Fig. 23.11 Non-structural elements and hazard map

23.5 Discussion and Conclusions

Education is always a big challenge in that it demands to establish a relationship between the researcher and the public, to gain trust before conveying the message, to be convincing and exhaustive but not authoritative.

KnowRISK Practical Guide is supposed not only to increase the level of education and to raise awareness of the readers, like in a standard educative process, but also to encourage the reader to undertake safety actions. It has some pros and cons in these regards. The con is that the guide warns that we may be in danger. Depending on where we live and how our house is set, we may be exposed to non-structural damages. Knowing that we are at risk makes us feels uncomfortable and a sort of defence gate must be overpassed to gain the trust from the reader. The "human" solution in such situations is often to neglect the problem: for this reason the guide has to be a "friendly" list of suggestions more than frightening warnings.

The pros are that the readers do not have a "time frame" to adhere to. They can devote as much time as they like and can go through the guide several times without any stress to act immediately; can decide what level of safety is acceptable: and accordingly decide on the different levels of intervention.

Given this, it must be remarked that the KnowRISK Practical Guide is a unique attempt not only to encourage a culture of safety, but also provide suggestions on how to increase it. To our knowledge, it is the first time that such an approach, where guide suitable for the layperson, is carefully designed and prepared in Europe. Most of the suggestions contained in the guide have been tested on the shaking table tests carried out during this project, which increases our confidence in their usefulness. It is not expected to be applicable in all situations, but will certainly be useful in raising awareness of seismic risk due to non-structural components and making the public realize that mitigation measures are not as difficult and costly as perceived by many. This Practical Guide will contribute to risk awareness if not to safety, and we strongly believe that this kind of initiatives should be undertaken in larger scales to get enhance social resilience. The Practical Guide will be complemented by the Portfolio, which provides solutions that are economically feasible and easy to implement, as well as more complex solutions related with architectural or electrical/mechanical components.

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