



nsm

non-structural risk mitigation

handbook



Turkish Red Crescent
Ata 1 sok. No: 32 Kızılay Ankara tel: 0312 430 23 00 www.kizilay.org.tr



B.U. KANDILLI OBSERVATORY AND EARTHQUAKE RESEARCH INSTITUTE
DISASTER PREPAREDNESS EDUCATION PROJECT

Çengelköy 81220 İstanbul t:0216.308 05 11/345 f:0216.332 90 94 email: iahep@boun.edu.tr internet: www.iahep.org



B.U. KANDILLI OBSERVATORY AND EARTHQUAKE RESEARCH INSTITUTE
DISASTER PREPAREDNESS EDUCATION PROJECT

Çengelköy 81220 İstanbul t:0216.308 05 11/345 f:0216.332 90 94 email: iahep@boun.edu.tr internet: www.iahep.org



Non-Structural Risk Mitigation Handbook


This project was funded by American Red Cross with generous support from Boğaziçi University, Disaster Preparedness Education Project, Kandilli Observatory and Earthquake Research Institute, Boğaziçi University Center for Disaster Management, and Turkish Red Crescent. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the American Red Cross.

authors: Rebekah Green, MSCE, Project Coordinator
 Ömer Çalışkan, Trade School Teacher
 Bilgen Sungay, Architect
 Zara Paci, Educator

advisors: Marla Petal, MSW, Disaster Preparedness Education Project Director
 Prof. Dr. Özal Yüzüğüllü, B.U. Prof. of Earthquake Engr.
 Utku Celep, MSEE
 Cüneyt Tuzun, MSCE

graphic designer: Burcu Kayalar







illustrators: Atıla Ulaş
 Baran Baran

 This publication was made possible through the support provided by the Office of Foreign Disaster Assistance, U.S. Agency for International Development, under the terms of Award No. AOT-G-00-00-00235-00. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U.S. Agency for International Development.

© Copyright 2003, Marla Petal, Rebekah Green, Boğaziçi University, Disaster Preparedness Education Project, Kandilli Observatory and Earthquake Research Institute, and the Center for Disaster Management.

Turkish edition by Beyaz Gemi Publishers.



	What is your wall or structural element type?					
	Brick Masonry		Concrete	Aircrete	Gypsum Board	Timber
How heavy is your furniture?						
	Plastic Masonry Wall Plugs	Standard Wall Plugs	Steel Expansion Bolts	Plastic Aircrete Wall Plugs	Gypsum Wall Plugs	Wood Lag Screws
0- 5 kg.	For light objects use size 6 Standard Wall Plugs			Size 10	Size 2 Size 3	4 mm. x 60 mm.
5 -50 kg.	Size 6	Size 7	Size 6	For items this heavy, attach directly to studs or use a wall bridge.		4 mm. x 60 mm.
50 -150 kg.	Size 8	Size 8	Size 8			6 mm. x 80 mm.
150 kg. +	To secure very heavy items, consult a engineer or professional for proper installation.					
NOTES:	It is best if plastic masonry wall plugs are long enough to pass through 2 holes in the clay tile in order to hold more securely.		Leave a 16 cm. space between expansion bolts	Leave a 15 cm. space between aircrete wall plugs	Size 2: 10 mm. board Size 3: 12 mm. board	

Enter date of completion:

- We held a family meeting to discuss our Family Disaster Plan.
- We identified the safest places in the house, and in each room. (Away from windows, large and heavy objects that can fall, and objects like heaters that can cause fire.)
- We identified exits and alternative exits from our house and building.
- We considered the special provisions we need for pets, people who don't speak the language of the country, elderly, disabled, and small children.
- We have enough water to last us a week (4 liters per person per day), and food for 3 days.
- We know how to turn off our electricity, water and gas.
- We know our out-of-area contact person(s) and phone number(s):
It's: _____
- We know where we would reunite
Inside the house: _____
Outside the house: _____
Outside the neighborhood: _____
- We know how to use a fire extinguishers.
- We keep shoes and flashlights by our beds.
- We have a good first aid kit.
- We collected our survival supplies, and made up our earthquake bags. (Flashlight, batteries, radio, first aid kit, change of clothes, cash, whistle, matches, 1 week prescription medication, paper and pencil, important phone numbers.)
- We made our copies of important documents, and key addresses and phone numbers, and keep them in our earthquake bag or with our out-of-area contact.
- We know never to light a match, lighter, or any other flame after an earthquake until we are sure there is no danger of escaping gas anywhere around.
- We're starting to spread the word to everyone we know.
- We know that we will only use the telephone in an emergency after an earthquake, so that the lines will be there for those who need them most. We will get our information from TV and radio.
- We have completed our Earthquake Hazard Hunt and have taken measures to protect ourselves.
- We plan to review our plan again every 6 months.

name _____
 address _____
 _____ e-mail _____
 telephone _____ date _____

The methods suggested in this education for reducing non-structural risk were based upon 8 months of research, testing, and calculations. This was done by a team of researchers at Boğaziçi University, Disaster Preparedness Education Project (DPEP), Kandilli Observatory and Earthquake Research Institute (KOERI), and the Center for Disaster Management (CENDIM).

Research:

Many of the suggestions in this education are based upon reports from past earthquake experiences and recommendations from governmental agencies in earthquake regions around the globe. Local industrial specialists were also consulted. In addition, countless people were interviewed regarding what they had done to reduce their risk. Their ideas were considered and their questions and concerns were taken into account.

Laboratory Tests:

Electronic equipment, white appliances, and large furniture items were attached to wall materials on a shake table using a variety of fastener types and installation methods. Effective and ineffective attachment methods were learned through hundreds of tests.



Shake Table: A platform attached to a computer and large motor. The motor and computer can cause the platform to shake similar to ground motion from an earthquake. A single degree of freedom shake table was used in our tests. It can only shake in one direction, forwards and backwards. It cannot move up and down or side to side like a true earthquake. A 6 degree of freedom shake table can fully simulate an earthquake.

Calculations:

When there were no tests or past research, engineering calculations were used. Recommendations for the size and number of attachments, wall plugs, and screws are based upon the International Building Code as well as manufacturer's guidelines.

Research regarding non-structural damage in earthquakes is a new field. Even newer are the ideas for reducing these risks. While people all over the world have found simple and innovative ways for reducing their risk, there are still many unanswered questions and puzzling problems. Everyone can play a part in finding solutions for these problems. Citizens should reduce the risks in their own surroundings. After an earthquake, they can also investigate how non-structural mitigation worked in homes, schools, and work places. Scientists and engineers can do further research and calculations. Technicians, entrepreneurs, handymen and even ordinary citizens can think of new earthquake safety products. It is only by working together that we can make our surroundings and communities safer and more resilient in the face of earthquakes.

GOALS

Major earthquakes can create devastating tragedies for a community including loss of life, injuries, loss of homes, work and community. However, we have learned from past earthquakes all over the world that much of this can be prevented. Many injuries, economic losses and even deaths can be avoided by simply making the items in our buildings safer during earthquakes.

Our mission is:

- To raise awareness regarding the risks that exist from non-structural items.
- To show how these risks can be identified.
- To encourage everyone to take simple steps to reduce these risks.

We would like to thank the Turkish Red Crescent Society and American Red Cross for seeing the value of this material and aiding in the development and dissemination of this education. This education program would not have been possible without the assistance of many people. We would especially like to thank the producers of non-structural mitigation products for sharing their experience and donating their products.

Adafix Endüstriyel Ürünler ve Hizmetler Tic. Ltd.Şti.
Depsis Deprem Sistemleri Teknolojisi İnşaat ve Tic. Ltd.Şti.
İNKA Yapı Boğlantı Elemanları Pazarlama Tic. Ltd.Şti.
İnteryön
Kaya Yapı San. Ve Tic. Ltd.Şti.
TNT İmalat ve Ticaret

We would like to thank the following companies for advising in their fields of expertise:

3M San. ve Tic. A.Ş. Endüstriyel Bantlar ve Yapıştırıcılar Grubu	Johnson Diversey
AKPEN San. ve Tic. Ltd.Şti.	Kelebek Mobilya ve Kontraplak San. A.Ş.
Arçelik A.Ş.	Koç TAŞ Yapı Market
Asansör İnşaat San ve Tic. Ltd. Şti.	LİRTEK Yapı Ürünleri ve Sistemleri
Bes-mak Sanayii ve Tic. A.Ş.	MAY Mahalle Afet Yönetimi Derneği
Buga Otis Asansör San. ve Tic. A.Ş.	Metal ve Yapı Sistemleri Tic. A.Ş.
Çelik Cam Plastik ve Alüminyum Pencere Sistemleri	Nalbur Birleşik Zincir Mağazalar A.Ş.
Datakom Elektronik Mühendislik Ltd.Şti.	Okan Cam Sanayii ve Tic. A.Ş.
Denge İnşaat Turizm San. Ve Tic. A.Ş.	Praktiker Yapı Marketleri A.Ş.
Edip Enerji Dizel A.Ş.	Rena Mühendislik Taahhüt ve Tic. Ltd.Şti.
Gemini Büro Sistemleri ve Donatım Ltd. Şti.	T.C. Emniyet Gen. Müd., İstanbul
Gülsan Şirketler Grubu	Polis Hastanesi
Hakon Mühendislik Elektrik Elektronik	Tek-İz İzolasyon ve Yapı Elemanları San. A.Ş.
	Teleset Mobilya San. Ve Tic. Ltd.Şti.
	Ulaş Metal San. ve Dış Tic. Ltd. Şti.

We are very grateful to the Ataşehir Rotary Club and Kandilli Observatory and Earthquake Research Institute who made the laboratory testing possible by allowing the use of their shake table.

Disclaimer:

Boğaziçi University, Kandilli Observatory and Earthquake Research Institute, and the Disaster Preparedness Education Project have tried to ensure the accuracy of this publication. However, earthquake engineering remains a new science and there is not enough information to fully predict the performance of non-structural items in future earthquakes, even if these guidelines are followed. Individual situations vary and it is the responsibility of the reader to carefully consider how to apply these recommendations to their own situation, and to seek expert guidance when in doubt. All parties assume no responsibility for the losses that may occur in an earthquake or as a result of applying these recommendations.

This handbook includes information about basic non-structural mitigation. You can find out more information from your instructor, www.iahep.org or www.kizilay.org.tr about the following items:

- Water Heaters
- Stoves and Heaters
- Signs, Air Conditioners, and Satellite Dishes
- Suspended Ceilings
- Pipes and Ducts
- Masonry Walls
- Chimneys
- Non-structural Exteriors
- Elevators, Escalators, and Moving Walks
- Large and Sensitive Equipment

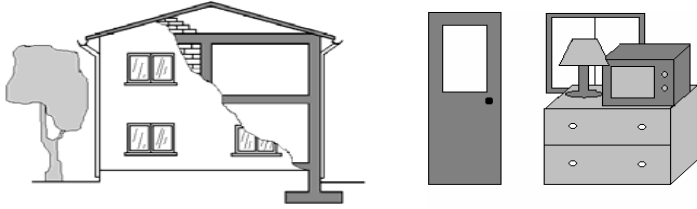
ANCO Engineers Inc, *Final Report on Seismic Testing of Your Calstraps Earthquake Safety Straps*, 1994.
 ATC-Applied Technology Council, "Briefing Paper 6: Seismic Code Requirements for Anchorage of Nonstructural Components" ATC/SEAOC Joint Venture Training Curriculum (ATC-48).
 ATC-Applied Technology Council, *Proceedings of Seminar on Seismic Design, Retrofit, and Performance of Nonstructural Components*, 1998.
 ATC-Applied Technology Council, *Proceedings of Seminar and Workshop on Seismic Design and Performance of Equipment and Nonstructural Elements in Buildings and Industrial Structures*, 1992.
 Beall, Christine. *Masonry and Concrete For Residential Construction*. New York: McGraw-Hill, 2001.
 City of Seattle Emergency Management, *Getting Ready...SDART'S Guide to Personal and Neighborhood Preparedness*, 2002.
 Coburn, Andrew and Spence, Robin. *Earthquake Protection*. New York : Wiley, 1992.
 Drake, Richard and Bachman, Robert. "NEHRP Provisions for 1994 Nonstructural Components." *Journal of Architectural Engineering*. Vol. 2, no.1 (March 1996).
 Erdik, Mustafa. *Report on 1999 Kocaeli and Düzce (Turkey) Earthquakes*. İstanbul: Boğaziçi University, Dept. Of Earthquake Engineering, 2000.
 FEMA-Federal Earthquake Management Agency, *1997 Edition, NEHRP Recommended Provisions for Seismic Regulations for New Buildings*, 1998.
 FEMA-Federal Earthquake management Agency, *A Nontechnical Explanation of the 1994 NEHRP Recommended Provisions*, 1995.
 Fierro, Eduardo; Perry, Cynthia; and Freeman, Sigmund. *Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide*. Washington D.C.: Wiss, Janney, Elstner Associates, Inc., 1994.
 Gad, E.F.; Lam, N.T.K.; Duffield, C.F.; Hira, A.; Chandler, A.M. "Seismic Behavior of Non-structural Components in High-Rise Buildings." 12th European Conference of Earthquake Engineering, 2002.
 ICBO-International Conference of Building Officials, *Uniform Building Code*, 1997.
 Kennett, Earle. *Seismic Considerations: Apartment Buildings*. Washington D.C.:Building Seismic Safety Council, 1988.
 Lagorio, Henry. *Earthquakes: An Architect's Guide to Nonstructural Seismic Hazards*. New York: Wiley, 1990.
 Moghaddam, Hassan and Mahmoodi, Ali. "Seismic Strengthening of Masonry Infilled Structures." 10th European Conference of Earthquake Engineering, 1995.
 Pal Singh, Mahendra; Rildova; and Suarez, Luis E. *Seismic Behavior of Rail Counterweight Systems of Elevators in Buildings*. New York: Multidisciplinary Center For Earthquake Engineering Research, 2002.
 Petal, Maria. Causes of Deaths and Injuries in the August 17th, 1999 3:02 a.m. M=7.4 Kocaeli Earthquake, Research Report, Boğaziçi University, CENDIM, İstanbul, 2003.
 Reinhorn, Andrei, M. P.E., Ph.D. *Evaluation of Tyfo-S Fiber Wrap System for Out of Plane Strengthening of Masonry Walls*. Buffalo: Department of Civil Engineering, State University of New York at Buffalo, 1995.
 Scholl, Roger; Lagorio, Henry; and Arnold, Chris. *Nonstructural Issues of Seismic Design and Construction*. New York: Multidisciplinary Center For Earthquake Engineering Research, 1984.
 Soong, T.T. "Seismic behavior of nonstructural elements-state-of-the-art report." 10th European Conference of Earthquake Engineering, 1995.
 Taylor, Andrew and Phan, Long. "Seismic Design of Non-Structural Building Components in the United States." Wind and Seismic Effects, 29th Joint Meeting of U.S./Japan Panel Proceedings, 1997.
 United States Testing Company, *Test Results on Q-Safety, Inc. Fastener Products*, 1995.

- I. NSM Principles
- II. Identification of Risk
- III. Before Mitigation
 1. Estimate Weight
 2. Choose Fastener Type and Number
 3. Decide Where to Fasten
 4. Choose Hardware for Attaching to Walls and Structural Elements
 5. Decide How to Attach Fasteners to Furniture
- IV. Basic NSM
 - Furniture
 - Electronics and Countertop Appliances
 - White Appliances
 - Hanging Items
 - Cabinets
 - Decorative Objects
 - Shelf Contents
 - Glass
 - Exits
 - Tanks
 - Lighting
- XV. After NSM . . .

This handbook includes information about basic non-structural mitigation. You can find out more information from your instructor, www.iahep.org or www.kizilay.org.tr about the following items:

- Water Heaters
- Stoves and Heaters
- Signs, Air Conditioners, and Satellite Dishes
- Suspended Ceilings
- Pipes and Ducts
- Masonry Walls
- Chimneys
- Non-structural Exteriors
- Elevators, Escalators, and Moving Walks
- Large and Sensitive Equipment

This book is designed to help identify non-structural hazards in our homes, schools, work places, and public spaces and show how these hazards can be reduced. Non-structural elements are all the parts of a building, its furnishings and contents, except the structure itself. In other words, they are everything but the columns, beams, floors, load-bearing walls, roof and foundation.



During an earthquake, some non-structural elements can pose danger to people or be damaged. We call the possibility of this danger or damage **non-structural hazard**.

The best way to find out if your home will be strong in an earthquake is by having an engineer inspect your building. However, it is important to realize that only 5% of the damaged buildings in the 1999 Izmit and Duzce Earthquakes totally pancake collapsed. In many heavily and moderately damaged buildings and even in some slightly damaged buildings, non-structural hazards accounted for serious injuries and huge economic losses.

Of the 1,500,000 people directly affected by these earthquakes, 1% lost their lives. While losing these people was an incredible tragedy, the remaining 99% of residents were left to try to resume living after the earthquake.

Taking precautions like those suggested in this handbook is one way that we can prepare for the next earthquake. These precautions will help make resuming life afterwards easier and quicker and will reduce economic loss. More importantly, they will reduce the number of lives lost. Even preventing small injuries allows priority to be given to those that are life threatening and helps to save lives.

Erdik, Mustafa. Report on 1999 Kocaeli and Düzce (Turkey) Earthquakes. Istanbul: Boğaziçi University, Dept. Of Earthquake Engineering, 2000.
Petal, Maria. Causes of Deaths and Injuries in the August 17th, 1999 3:02 a.m. M=7.4 Kocaeli Earthquake, Research Report, Boğaziçi University, CENDIM, Istanbul, 2003.

“What’s the point of worrying about non-structural risk, don’t most buildings completely collapse anyway?”

NSM is still a new subject and new things are learned every day all over the world. This learning process has already started in Turkey. People who see the importance of NSM have begun mitigating hospitals, museums and their own homes and workplaces. These pioneers have not only learned ways to improve NSM, they have also learned the importance of maintaining their work and making NSM a way of life.

As problems occur, they should be seen as clues to better solutions, rather than as failures.

- When plastic clip and strap fasteners first started being used in Turkey, it was found that they were easy to leave open. Because of this, an improved locking fastener was produced.
- After seeing that suspended ceilings broke apart and fell during earthquakes in the United States of America, it was clear that the methods used for attaching them were not sufficient. These methods have also been improved and tested through a series of earthquakes.
- Self-adhesive fasteners have come unattached after use and wear. This has made everyone more aware of the importance of inspection and maintenance.

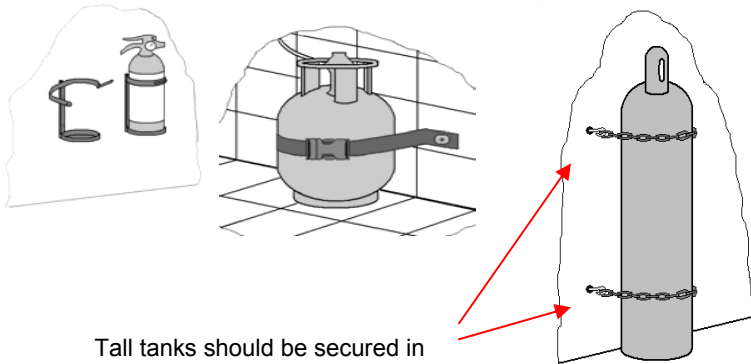
In everything we do, we need to continue to ask how we can improve.

In order for NSM to be successful, everyone must be educated and part of the process. The measures taken will become ineffective and quickly fall into disuse if they are considered to be a hindrance to the flow of daily life. The responsibility for addressing this issue falls upon the installers of NSM. It is very important to explain how and why measures can help protect our lives and include everyone in the decision making process during installation. This will create users that become advocates for their permanence.

Everyone who learns about this topic realizes that their job is not finished after simply doing NSM. We recognize that this will become a part of our lives. At regular intervals we will need to check our fasteners. When rearranging or buying furniture we will need to consider how we will secure it and buy the necessary materials. While these new habits may come with difficulty at first, with time we will become accustomed to them and making things safer will become automatic. As we share this knowledge and expertise with those around us and our information increases, even more attractive and easy solutions will emerge.

Non-structural mitigation is a shared responsibility. After earthquakes occur, all of our observations and thoughts regarding improvements will help our knowledge to grow. In order to make our communities more resilient in the face of this type of disaster, everyone must play a role.

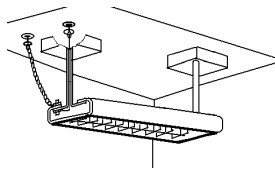
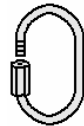
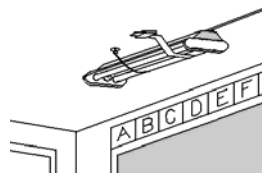
Tanks and fire extinguishers can be attached in many different ways to help keep gas from escaping and the tank from toppling in an earthquake.



Tall tanks should be secured in **two locations**, near the top and bottom.

There are many things that can be done to keep lighting from falling and causing harm during earthquakes:

- Attach lighting to structural elements
- Secure florescent tubes to casings
- Secure hanging lights with safety cables
- Secure heavy hanging lights with locking hooks
- Keep wires and ballasts neatly secured
- Attach floor lamps to the wall
- Secure tabletop lamps with glass shades to tables and shelves



NON-STRUCTURAL HAZARDS ARE SERIOUS

Non-structural hazards are the cause of a huge number of avoidable injuries and deaths. They also hinder rescue and aid efforts, cause great economic loss and make resuming everyday life harder.

Did you know?

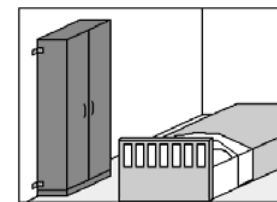
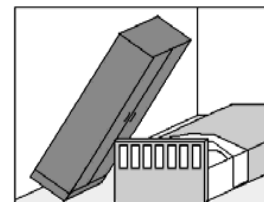
- 50% of the injuries and 3% of the deaths in the İzmit Earthquake of 1999 were caused solely by non-structural hazards.
- After the İzmit Earthquake of 1999, survivors estimated that 30% of their economic losses were due to loss of furniture, equipment and other valuable non-structural objects.
- Non-structural damage in earthquakes has caused businesses to close, jobs to be lost, and schooling to be interrupted.
- After the United States Northridge Earthquake of 1994, ten essential hospitals with little or no structural damage needed to be evacuated or closed because of non-structural damage. As a result, medical response was severely disrupted.

Petal, Marla. Causes of Deaths and Injuries in the August 17th, 1999 3:02 a.m. M=7.4 Kocaeli Earthquake, Research Report, Boğaziçi University, CENDIM, Istanbul, 2003. Fierro, Eduardo; Perry, Cynthia; and Freeman, Sigmund. *Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide*. Washington D.C.: Wiss, Janney, Elstner Associates, Inc., 1994.

NON-STRUCTURAL RISKS CAN BE REDUCED

There are many ways that non-structural risks can be reduced. These range from simple solutions that you can do yourself to complex solutions that require professional help. The process of risk reduction is called **Non-Structural Mitigation** or **NSM**.

Risks are reduced through a series of steps and every step is important. This education is intended to help you take these steps, one by one.



OBJECTS CAN SLIDE AND FALL IN MANY DIRECTIONS

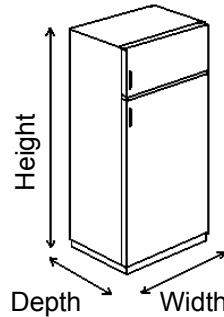
When identifying non-structural hazards, it is important to remember that earthquake forces are different than the gravitational force that we feel every day. When we drop something it falls straight to the ground. The gravitational force of the earth pulls the object down to the ground. However, earthquake waves may come from any direction. It is important to consider all possible directions when looking for items that can topple or slide.

ITEMS THAT WILL TOPPLE EASILY:

1. **Objects that are taller than they are deep or wide:**

If the height is MORE than 1 ½ times the depth it can easily topple forwards and backwards.

If the height is MORE than 1 ½ times the width, it can easily topple to the side.

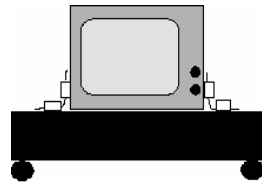


2. **Objects that are top heavy:**

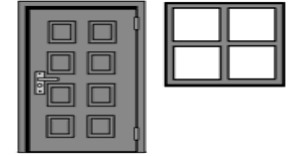
These objects can easily topple in all directions.

ITEMS THAT WILL SLIDE EASILY:

1. Objects that have wheels
2. Objects that are too low to topple
3. Objects that are on a slippery floors, like tile or wood
4. Objects that are much heavier on the bottom than on the top

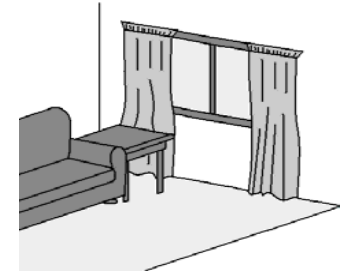


It is especially important to make sure that glass in crowded public spaces such as shopping areas, large terminals, hospitals, theatres, schools, and places of worship will not pose serious risk.



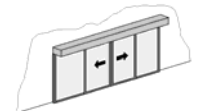
- Rearrange furniture and hang long curtains
- Use laminated glass
- Use tempered glass
- Install security film

Not all glass furniture is made from the same type of glass. Furniture made from **tempered** or **laminated** glass is safer when it breaks. When purchasing furniture with glass parts it is important to find out what type of glass it is made from.



After an earthquake, people may need to quickly, but calmly exit buildings. Here are several steps that can be done to make exiting easier:

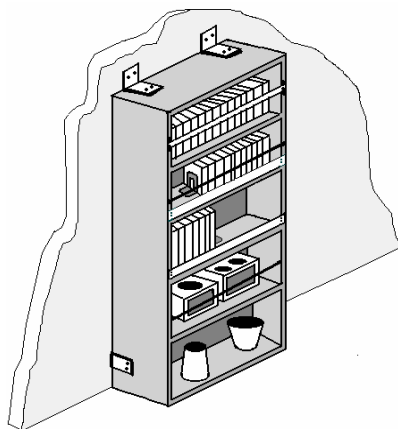
- Keep items that may hinder evacuation away from exit doors
- Install outward opening doors
- Create wide exits
- Ensure that doors open easily
- Install service entrances adjacent to revolving doors
- Use a single secure door instead of an added security gate
- Keep fire exits unlocked and install panic bars
- Place strong levers to use in case of emergency near heavy exit doors and barred windows
- Install back-up systems for electric automatic doors and gates



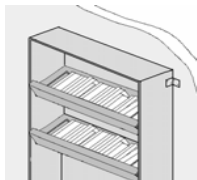
Some items on shelving are more important to secure than others. Here are some items that may be irreplaceable, cause harm, be hard to reorganize, or be needed immediately following an earthquake:

- Stored museum collections
- Dangerous chemicals
- Files
- Large collections of books
- Emergency equipment
- Medical supplies

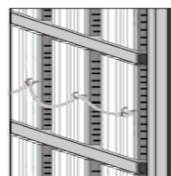
- A removable wooden or metal bar can be placed across each shelf at mid-height.
- A metal, plexiglass, or wood "lip" can be screwed to each shelf.
- An elastic band or wire can be added as well.
- Small items and bottles can be secured in larger boxes in a way that they will not hit each other.
- Heavy or dangerous items should be placed on bottom shelves.



Be sure that unsecured heavy objects are placed below the height of the lowest person in your household.



Important books

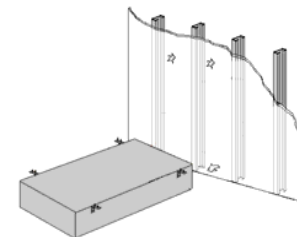


Valuable files such as medical records and other important documents

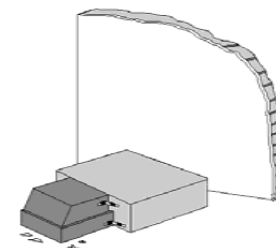
OBJECTS SHOULD BE SECURED TO STRUCTURAL OR SOUND NON-STRUCTURAL ELEMENTS TO PREVENT TOPPLING AND SLIDING

Our objective is to make the objects move with the structure of the building, rather than being thrown about inside it. Sometimes objects can be attached to the structure and other times to strong and secure non-structural elements instead.

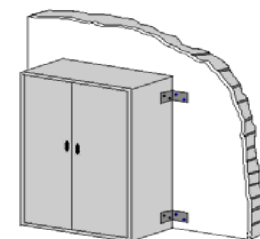
Gypsum board, aircrete and adobe are weak wall materials that need special consideration.



It is important to consider how secure shelves, cabinets, and tables are before securing items to them.

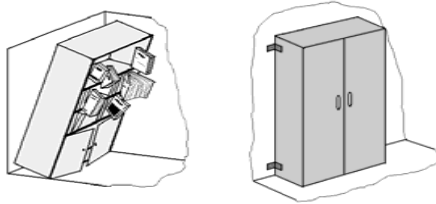


Masonry walls, although they are non-structural elements, can be a good place to attach items when they are made from strong brick and mortar.



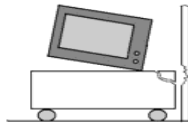
FURNITURE SHOULD BE SECURED FROM THE LOCATIONS THAT WILL MOVE THE MOST

When we attach non-structural items to structural ones, they are less likely to topple, hurt someone or be damaged. However, where and how we attach these items is also very important. Attaching furniture items incorrectly can make non-structural mitigation less effective or even be of no help at all.

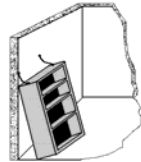


OBJECTS SHOULD BE SECURED TIGHTLY TO PREVENT THEM FROM HITTING PEOPLE AND EACH OTHER

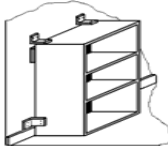
When objects are allowed to hit people, each other, or parts of a building they will cause damage and injury.



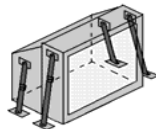
When furniture is secured loosely or with a large space between it and the wall, it can still violently hit the wall during an earthquake. For this reason it is best to attach items as tightly as possible.



If a space remains between the wall and a secured item, placing a **bumper** in the space can protect both the furniture, the wall and the fastener.



When using nylon straps and plastic clip and strap fasteners, the straps should be tightened so that the secured object does not move around and strike anything.



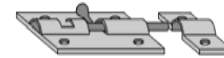
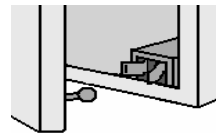
Earthquake Hold and Rubberized Shelf Mat



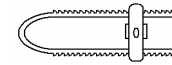
Remember to clean well!

Cabinet doors should be kept from opening and spilling their contents during earthquakes.

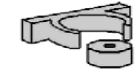
Mechanical Latches



Child Proof Safety Latches



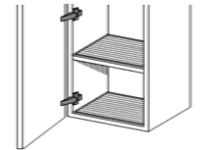
Magnetic and Click Latches



It is important to close cupboards containing **heavy items** with mechanical or child proof latches.

Magnetic and other lightweight latches should only be used for cupboards containing **lightweight objects**.

Rubberized shelf mat will also help keep low objects inside cabinets from sliding.



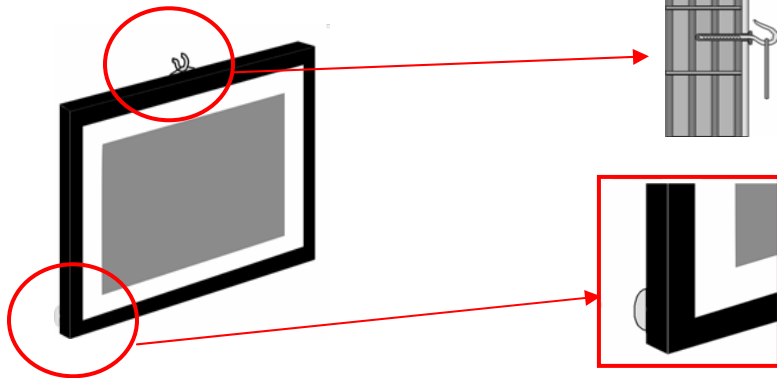
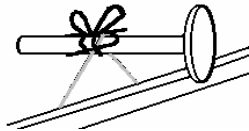
Earthquake hold can be placed on the bottom of fragile items to secure them.



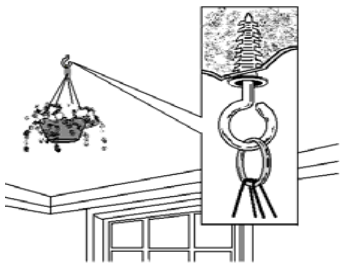


Metal Hooks and Earthquake Hold

If your lightweight pictures are already hanging on nails in the wall, you can secure them with strong twine without removing the nail.



Secure the bottom edges of pictures and mirrors with earthquake hold to keep them from banging against the wall and breaking.

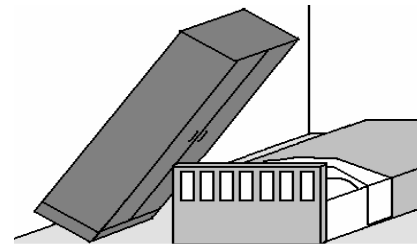


Carefully choose a location to attach hanging objects like flower pots. This location should not be near windows, walls, or other objects.

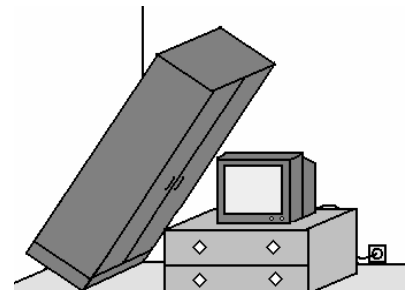
Close the opening of the hook with a pair of pliers to prevent the object from jumping off the hook during an earthquake.

Earthquakes are a risk that we accept by living in an earthquake region. We face many other risks in our lives as well and we take precautions to reduce our losses from them. NSM is reasonable precaution against earthquake risks from the non-structural elements of buildings. To decide what NSM is necessary, you need to identify what risks exist in your home, school, workplace, and the public spaces that you frequent. This risk varies from situation to situation. It is important to evaluate each situation individually.

RISK: SERIOUS INJURY OR DEATH



RISK: DAMAGE TO BELONGINGS



DECIDING WHAT TO DO FIRST

1. The first step to reducing non-structural risk can be to rearrange furniture and other items. Think of the places where your family, your students or your co-workers spend the most time.

Are there any heavy tall items that you could move to safer locations?

Can furniture that people sit in often be moved away from windows?

Are there any large items that can be moved to lower shelves?

Are there any items that you are no longer using that can be removed?

2. Now, identify the rest of your risks using the hazard hunt.

In general, items that are taller and heavier, that can fall on us while we sleep or block exits, contain hazardous materials, are important to daily life, or are expensive should be considered first.

3. Reduce all the risks you can by using the simple instructions in this book.

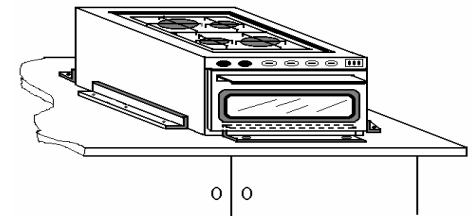
4. Consult a professional to help you reduce any remaining risks.



Metal L-shaped Angle

Securing countertop appliances that may be hot or that are attached to gas lines can help prevent burns, gas leakage and fires.

The angle should be tall enough to come up the side of the appliance and hold it in place. It does not need to be attached to the appliance surface.



L shaped angle can be attached to a well cleaned countertop using any of the following options:

- **Screws**, and if necessary wall plugs, appropriate for your type of counter top.
- Double sided self adhesive tape found in many large hardware and do-it-yourself stores. Look for tape labeled “**mirror attachment tape**” as it is sufficiently strong.
- Strips of **self-adhesive hook and loop tape**, commonly called self-adhesive Velcro™, found at large hardware and do-it-yourself stores. Stick one side of the hook and loop to the counter and the other to the bottom of the L profile or bracket.



Plastic Clip and Strap Fasteners



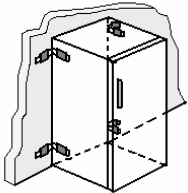
After 24 hours, tighten all straps!



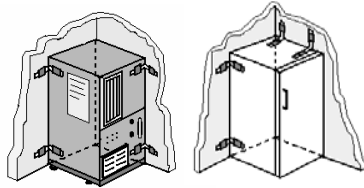
Remember to clean well!

Use plastic clip and strap fasteners only on small white appliances that are **counter height or lower** and weigh **less than 35 kg**. (e.g. dorm size refrigerators, etc).

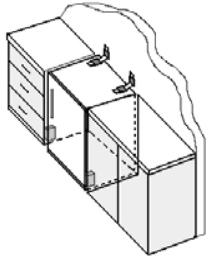
ATTACHING TO A BACK WALL



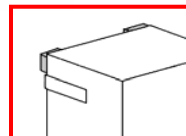
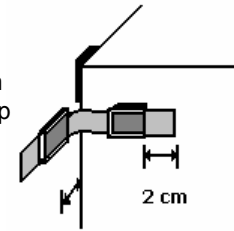
ATTACHING IN A CORNER



ATTACHING IN A NICHE



Be sure to leave about a 2 cm. tail on each end of the strap so that the strap cannot easily be pulled out of the fastener. A 2 cm. tail will also ease tightening.

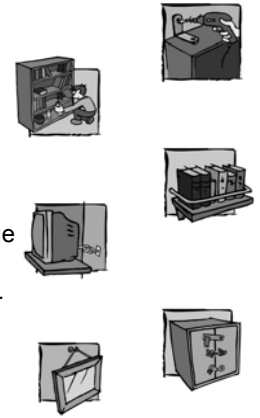


Do not forget to use padding when necessary!

The Earthquake Hazard Hunt should begin at home, with all family members participating. Imagination, and common sense are all that are needed as you go from room to room and think about what will happen when the earth starts shaking. Check for objects that may slide, fall, and fly where people spend the most time - where they sleep, eat, work and play. Do some detective work! Make a list of what needs to be done and tackle it one by one until it's finished!

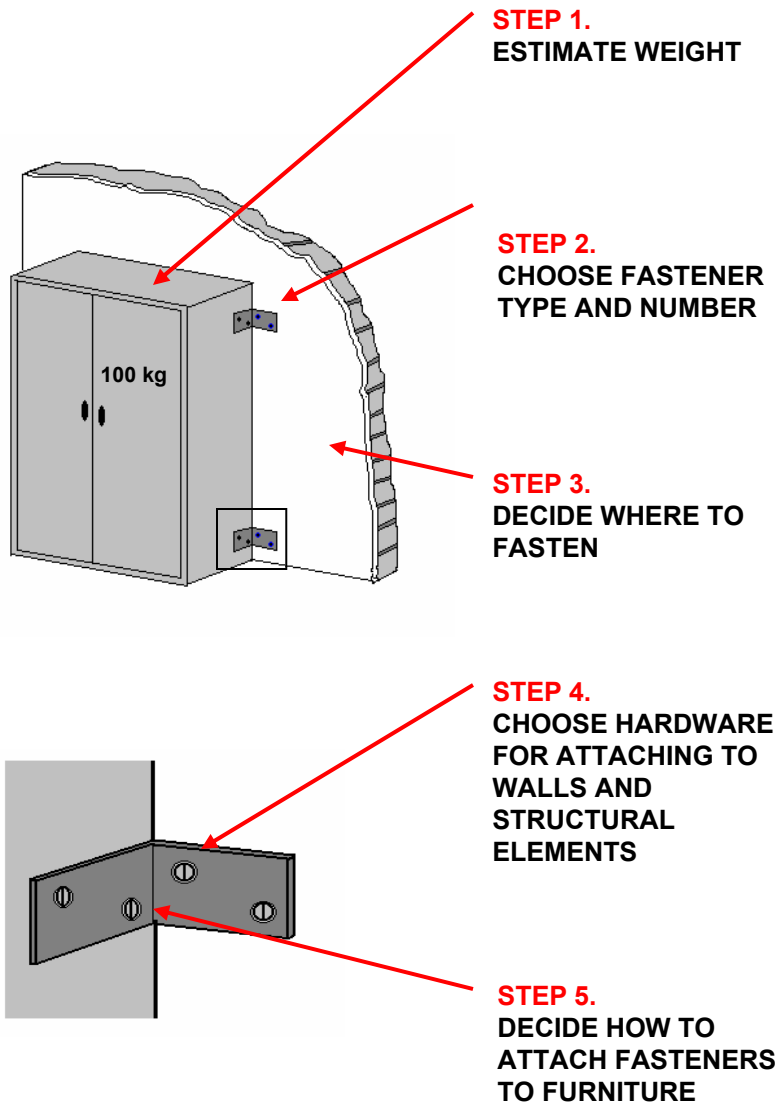
As you tackle what needs to be done, prioritize the items as follows:

1. **Secure life threatening items first (eg. wardrobes in bedroom or things blocking exit)**
2. **Secure those things that would entail significant economic loss (eg. computer, a/v equipment)**
3. **Secure those items that will let you live more comfortably (eg. family heirlooms, breakables)**
 - Move heavy items below the head level of the shortest family member.
 - Tightly secure furniture to walls (including kitchen cabinets).
 - Make sure white appliances and hot water heaters are secure.
 - Fasten LPG tanks and other gas cylinders to the wall.
 - Make glass that may break into large shards less dangerous (hang long curtains, rearrange furniture, install strengthened glass.)
 - Secure heavy and important electronic items.
 - Secure light fixtures to the ceiling.
 - Fasten pictures on closed hooks.
 - Check for any hazardous materials (poisons, flammable materials); make sure they are secure.
 - Consider replacing kitchen cabinet latches with ones that will hold shut during a quake.



Hazards we found:

Date corrected:



Nylon Straps



After 24 hours, tighten all straps!

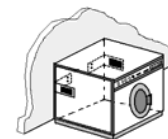
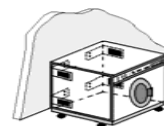
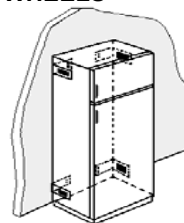


Remember to clean well!

ATTACHING TO A BACK WALL

Items up to **130 kg.** or **WITH WHEELS**

Low Items up to **65 kg.** **WITHOUT WHEELS**

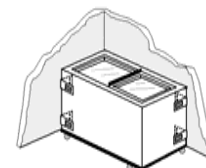
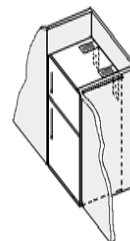


ATTACHING IN A NICHE

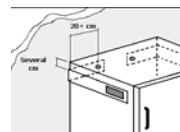
Items up to **120 kg.** or **WITHOUT WHEELS**

ATTACHING IN A CORNER

Items up to **120 kg.** or **WITHOUT WHEELS**



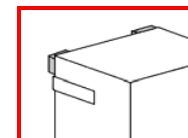
Nylon straps should be attached to the wall behind appliances at least 20 cm. from their edge. This will help ensure that the hook and loop attachment will not come undone when the appliance is shaking during an earthquake.



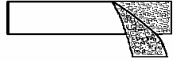
X NO



Do not forget to use padding when necessary!



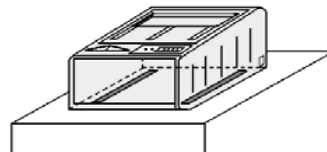
ELECTRONICS AND OTHER ELECTRIC EQUIPMENT



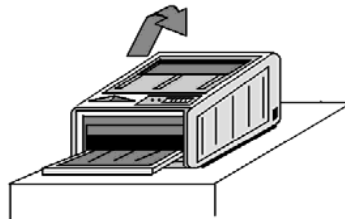
Self-adhesive Hook and Loop Tape

Self-adhesive hook and loop tape can be used for **light** equipment that is **low and will slide**, but will not tip over during an earthquake.

Attach one strip on each side of the bottom of the equipment.

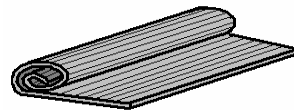


To temporarily remove electronics attached to surfaces with self-adhesive hook and loop tape, gently but firmly pull up on a single corner of the equipment.



Wait at least 24 hours before first removing the equipment in order to allow the self-adhesive to completely set.

If using self-adhesive hook and loop tape is not possible, placing a large piece of non-slip material underneath the entire under surface of the equipment can help reduce the amount it will slide.



! Do NOT use self-adhesive hook and loop tape on large televisions or other equipment that can topple.



Remember to clean well!

STEP 1. ESTIMATE WEIGHT

The pictures below may be helpful when estimating weight.

Approx. 200 kg.



Large office equipment
150-175 kg.

Approx. 150 kg.



Large refrigerator
100-150 kg.



Large furniture
100-200 kg.

Approx. 100 kg.



135 mm television
100 kg.



Midsize refrigerator
90-120 kg.

Approx. 50 kg.



Washing machine
50-75 kg.



72 mm television
50 kg.

Approx. 25 kg.



Mini Oven
30-40 kg.



Small furniture
25-50 kg.



55 mm television
25 kg.



Small electronics
20-30 kg.



Small furniture
under 25 kg.

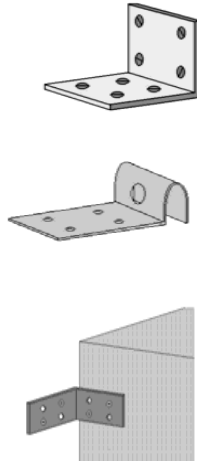


Small office equipment
under 25 kg.

STEP 2. CHOOSE FASTENER NUMBER AND TYPE

STANDARD AND SPECIALITY L BRACKETS

- Weight of furniture:**
 0-50 kg. – small L brackets
 50-100 kg. – medium L brackets
 100-150 kg. – large L brackets
- Space between wall and furniture:**
 If there is a space between the wall and the furniture, you may need to choose a larger bracket so that the holes on the furniture side are usable.
- Width of bracket:**
 Choose wide L brackets with more than one row of holes. When screws are placed in the holes closest to the bend and in a diagonal pattern they work best.

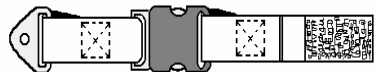


NYLON STRAPS

When you use nylon straps with hook and loop tape (Velcro™), it is important to make sure that the pad that you are attaching with is big enough for the weight of your object.



0-50 kg. - small nylon straps
 Each strap you use should have at least 25cm² industrial strength Velcro™ or similar hook and loop products



50-100 kg. - large nylon straps
 Each strap you use should have at least 50cm² industrial strength Velcro™ or similar hook and loop products

- televisions
- monitors
- small office equipment
- small copy machines
- small laboratory equipment
- white appliances
- large screen televisions
- copy machines
- workplace equipment
- equipment on wheels which must be moved

ELECTRONICS AND OTHER ELECTRIC EQUIPMENT

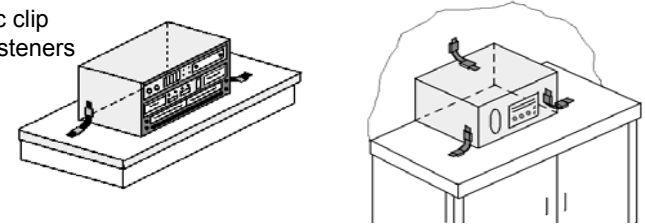

 Plastic Clip and Strap Fasteners


 After 24 hours, tighten all straps!


 Remember to clean well!

37 mm. screen televisions or electronic equipment up to 20 kg.

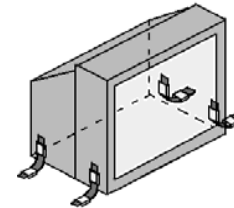
2 or 3 plastic clip and strap fasteners



When using two fasteners on small equipment, be sure to secure them on diagonal corners.

55 mm. screen televisions or electronic equipment up to 40 kg.

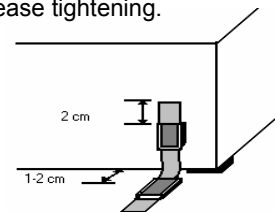
4 plastic clip and strap fasteners



STACKED EQUIPMENT

When attaching the base item to the table, be sure to use sufficient number of fasteners for the **combined weight** of all the items stacked together.

Be sure to leave about a 2 cm. tail on each end of the strap so that the strap cannot easily be pulled out of the fastener. A 2 cm. tail will also ease tightening.





Nylon Straps

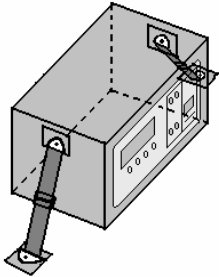


After 24 hours, tighten all straps!

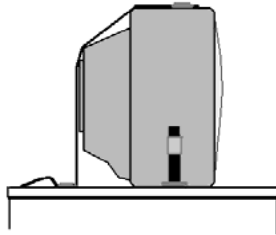


Remember to clean well!

70 mm. screen televisions or electronic equipment up to **35 kg.**

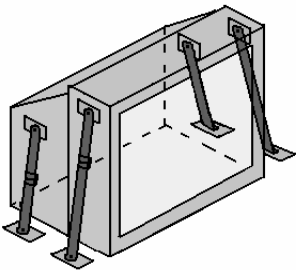


2 nylon straps



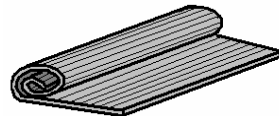
1 nylon strap and 2 plastic clip and strap fasteners

84 mm. screen televisions or electronic equipment up to **60 kg.**



4 nylon straps

Placing non-slip material underneath electronic equipment can also help reduce the amount the equipment will slide during an earthquake.



! For big screen televisions and other large electronic equipment, see the section on white appliances for proper fasteners and attachment methods.

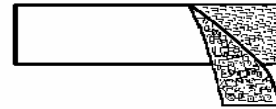
PLASTIC CLIP AND STRAP FASTENERS



- 35 kg. or lighter
- counter top height or lower

- small and medium electronics
- computers, fax machines, printers, and similar equipment
- countertop appliances
- mini (dorm size) refrigerators and freezers
- countertop laboratory equipment

SELF-ADHESIVE HOOK AND LOOP TAPE



- low table top items that will slide

- low fax machines, printers and similar equipment
- vcr and dvd players, or low stereos
- telephones, clocks, and similar equipment

This handbook will tell you which fasteners are appropriate for particular items and how many of them you will need. You can use this information to easily determine what supplies are necessary to purchase.

WHERE TO FIND NSM SUPPLIES

Large home improvement stores:

L brackets, cabinet latches, hooks, non-slip material, nylon webbing for straps, metal angle, self-adhesive hook and loop tape, and plastic clip and strap fasteners (at some locations)

Small hardware stores:

L brackets, cabinet latches, hooks, rubber shelf mats, and metal angle

Boating stores:

Nylon webbing for straps, fishing line, and cabinet latches

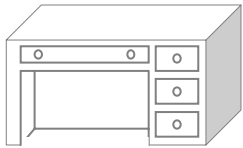
Specialty earthquake safety product distributors:

Plastic clip and strap fasteners, small and large nylon straps, specialty L brackets, and picture hangers

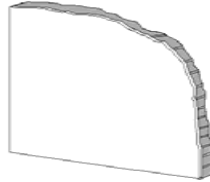
STEP 3. DECIDE WHERE TO FASTEN

FURNITURE

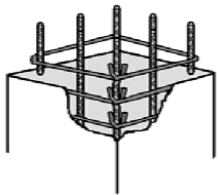
DESKTOPS, TABLES AND WORKSPACES



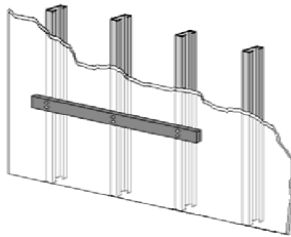
WALLS



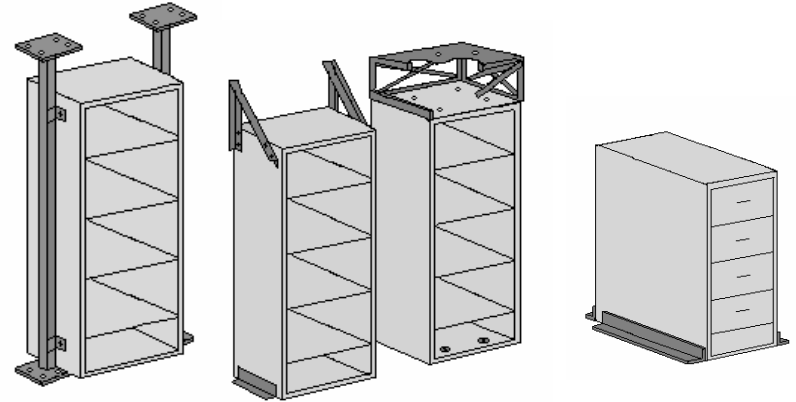
COLUMNS, BEAMS AND FLOORS



WALL BRIDGES



When items must remain free-standing, or the space between the their top and the ceiling is small, the methods show below can help reduce the risk of them **toppling** or **sliding**.



Wall Types Not Strong Enough for Securing Non-structural Items

- Gypsum Board
- Traditional infill walls (*bağdadi* and *hımış*)

Solution

Attach directly to the studs or make a wall bridge between the wood studs or timber framing members.

- Aircrete
- Very weak masonry walls (the mortar easily turns to sand when you rub it between your fingers)

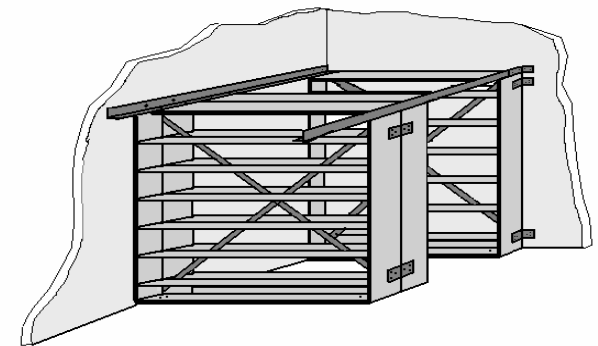
Make a wall bridge between columns, also attaching the wall bridge to the wall at 15 cm. spacing. Alternatively, secure items to structural elements.

- Adobe
- Rubble stone

Attach to wood structural members in the floor and ceiling.

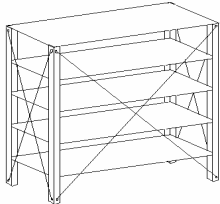
! For large free standing shelving, **consult an engineer** to determine appropriate size steel angle, bolt sizing, and connection placement.

Row shelving can be secured by using steel L angle to secure the tops of the shelves together. The steel L angle must then be securely fastened to the wall.

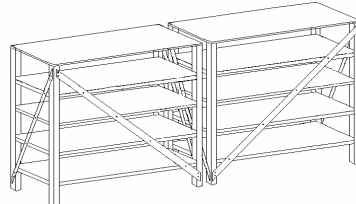


Shelf bottoms should also be attached directly to the floor using expansion bolts or L angle.

Open shelving must be braced before it can be secured to walls and floors. This bracing will ensure that the shelving cannot easily sway from side to side and collapse.

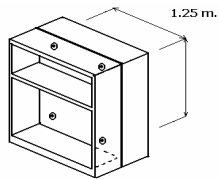


Flexible bracing

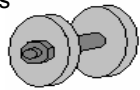


Rigid bracing

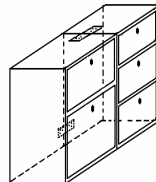
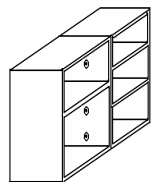
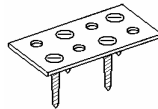
When you attach furniture together you create one object that is wider or deeper than the original individual objects. This can make the items more stable and less likely to tip over during an earthquake.



M8 bolts and oversized washers
-or-
furniture attachment bolts









Metal plate connected with 4
5 mm. or larger diameter screws
-or-
2 M8 or larger diameter bolts and oversized washers.



Once furniture has been attached together, you need to check whether its height is 1 1/2 times its new width and depth. If it can still topple, securing it to a wall, floor or ceiling is necessary.

STEP 4. CHOOSE HARDWARE FOR ATTACHING TO WALLS

Wall plugs, expansion bolts, and screws are designed and manufactured to work best when used with the correct material. Use the table below to determine the size wall plug, lag screw or expansion bolt you will need. You can figure out how many you will need by looking at the instructions for your type of furniture.

		What is your wall or structural element type?					
		Brick Masonry	Concrete	Aircrete	Gypsum Board	Timber	
How heavy is your furniture?							
		Plastic Masonry Wall Plugs	Standard Wall Plugs	Steel Expansion Bolts	Plastic Aircrete Wall Plugs	Gypsum Wall Plugs	Wood Lag Screws
0- 5 kg.	For light objects use size 6 Standard Wall Plugs			Size 10	Size 2 Size 3	4 mm. x 60 mm.	
5 -50 kg.	Size 6	Size 7	Size 6	For items this heavy, attach directly to studs or use a wall bridge.		4 mm. x 60 mm.	
50 -150 kg.	Size 8	Size 8	Size 8			6 mm. x 80 mm.	
150 kg. +	To secure very heavy items, consult an engineer or professional for proper installation.						
NOTES:	It is best if plastic masonry wall plugs are long enough to pass through 2 holes in the clay tile in order to hold more securely.	Leave a 16 cm. space between expansion bolts	Leave a 15 cm. space between aircrete wall plugs	Size 2: 10 mm. board Size 3: 12 mm. board			

STEP 5. DECIDE HOW TO ATTACH FASTENERS TO FURNITURE

FURNITURE SCREWS

Always use at **least two screws** per fastener when attaching a fastener to a piece of furniture. Use more for heavy items or consider using bolts.

Solid Wood Screws

In order to avoid causing wood material to break or crack, drill pilot holes when using screws over 4 mm. in diameter or 45 mm. in length. Use a drill bit half the diameter of the screw when making the pilot hole.

Plywood, Pressboard and MDF Screws

Sheet Metal Screws

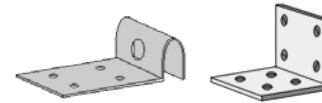
Metal screws need to be selected based upon the thickness of the metal to which the screw will be attached. The teeth of the metal screw should be wider than the thickness of the metal.

FASTENERS WITH SELF-ADHESIVE

It is always stronger to attach an item with screws. However, there are times when items cannot be screwed into. In these instances self-adhesive pads are often used. When using fasteners with self-adhesive attachments, it is **very important** that surfaces be **clean** and **completely dry**.

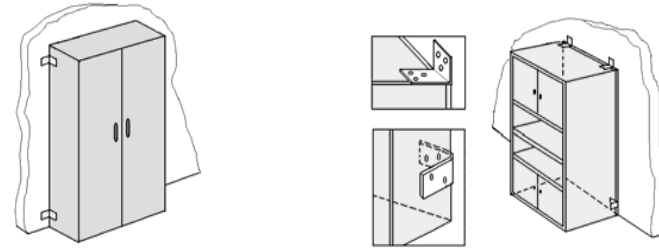
Cleaning products:

- **Special surface primer** sold by manufacturers of self-adhesive is the best possible cleaning solution.
- **Isopropyl alcohol** found at local pharmacies is also recommended by manufacturers.
- Alcohol based **window cleaner** purchased at your local grocery store is also a good alternative and is easy to use.

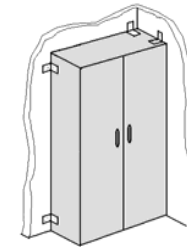


Standard and Specialty Metal L Brackets

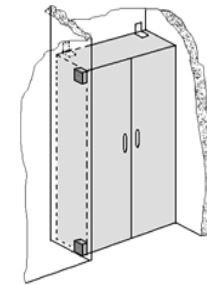
ATTACHING TO A WALL



ATTACHING IN A CORNER



ATTACHING IN A NICHE



Some furniture can be secured by screwing the back directly into the wall.

- **The back panel of the furniture must be thick and strong.**
- Distribute the attachments evenly across the back panel.
- Spaces between attachments should be no more than 1.25 meters in each direction.

Do not forget to use padding when necessary!

