Generic steps for a sustainable reconstruction process in Turkey

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International Initiative for Sustainable Built Environment (iiSBE)

10 May 2023

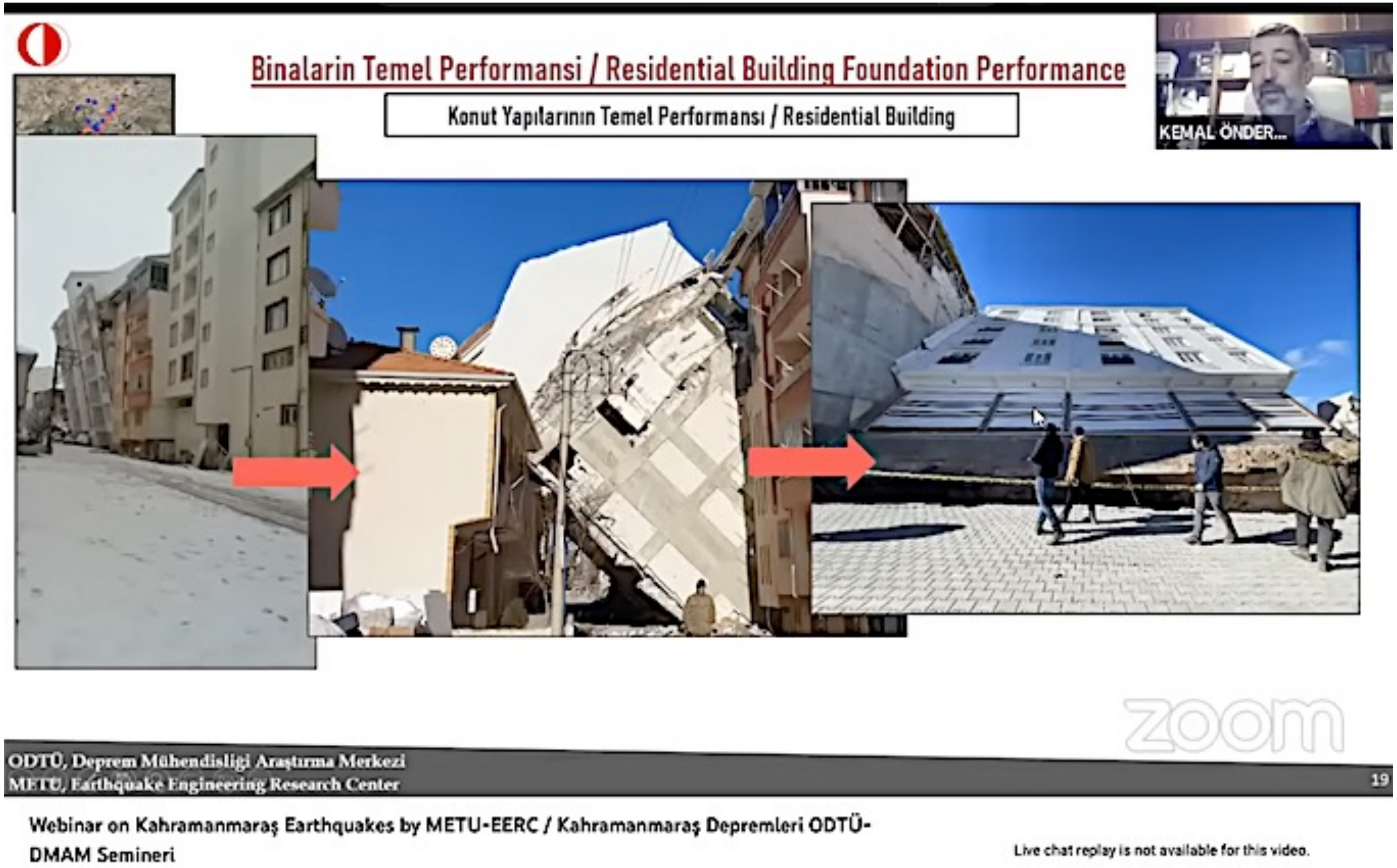
Issues related to and actions proposed for the Sustainable Reconstruction of damaged areas in Turkey

This file has been prepared by iiSBE and other concerned colleagues to support the efforts of Turkish professionals and students who are, under conditions of extreme pressure, developing plans and actions to quickly meet the emergency.

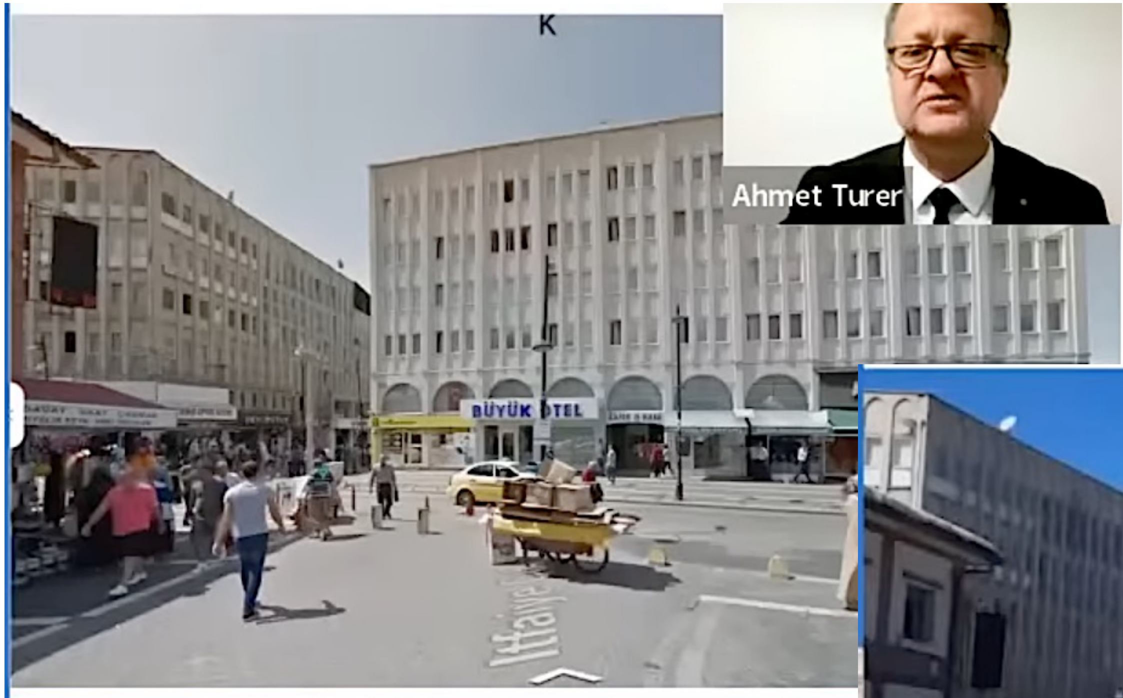
iiSBE’s interest and concern in this activity is to ensure that the need for a rapid reconstruction process does not overlook the need to consider careful consideration of long-term sustainability issues.

The following pages show our attempt to reconcile these two objectives.

Key steps related to a sustainable reconstruction process in Turkey



Key steps related to a sustainable reconstruction process in Turkey



Before

After

Proposals for actions applicable to urban zones in all regions

- Preserve and repair local ecological systems and natural landscapes.
- Protect critical facilities, infrastructure and services, e.g. power generation, public transport, health, education and safety services.
- Support conversion to clean energy and renewables.
- Limit peak electrical demand to reduce demand for new generating facilities.
- Where clusters of new buildings with different occupancies and configurations are located in close proximity, consider the use of a synergy zone approach to balance excesses and deficiencies in thermal energy, renewable energy outputs or greywater.
- Develop long-term improvement strategies and key performance targets for neighbourhoods.
- Emphasise mixed uses to optimise land use and to reduce commuting.

Proposals for actions applicable to urban zones in all regions

- Shift from private to public transport to reduce emissions and area used for roads and parking.
- Prioritise use of available land for green space, urban agriculture, parks, playgrounds, pedestrians and bicycle paths.
- Minimise heat island effect through increased use of high-albedo surfaces, shade trees and other vegetation.
- Enable recharge of aquifers through use of permeable paving on streets and public areas.
- Plan street and building forms to support passage of breezes during hot seasons and to minimise cold winds during winters.
- Where new construction is required, maximise the efficiency of land use through compact building forms and building coverage ratios.
- Protect local culture, social structures and local employment during the reconstruction process.

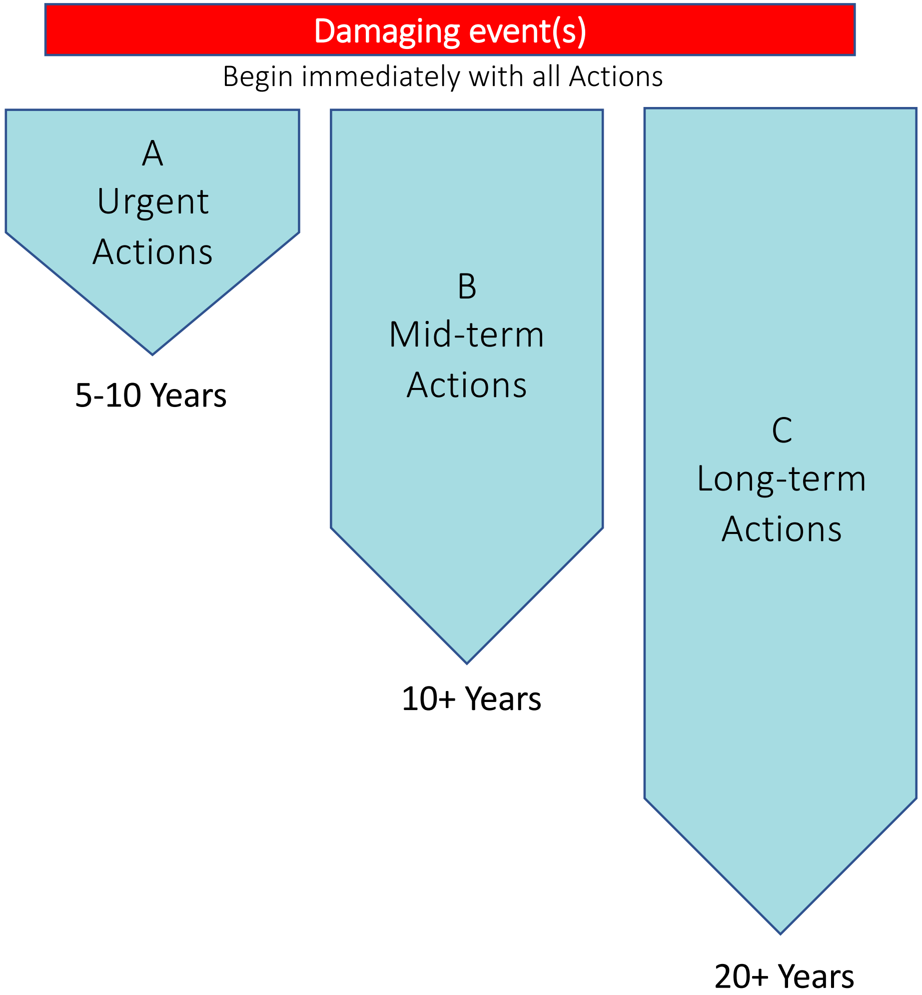
Proposed Actions by Phase

We propose measures that should be undertaken to protect the lives and activities of populations subject to major disasters such as earthquakes.

Our separation into three action time scales recognizes that some measures can (and must be) implemented very quickly, while others take much longer to complete.

As the diagram indicates, this does not mean that Mid-term or Long-term actions should await the completion of a previous stage.

In other words, work on all reconstruction actions should begin immediately after the damaging event, even if the development and implementation of many of these measures will take longer than the Urgent actions.



Key steps related to a sustainable reconstruction process in Turkey

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Damaging event(s)

1. Prepare damage maps
2. Identify weaknesses in seismic regulations
3. Identify areas where construction is to be avoided
4. Identify priority reconstruction areas
5. Assess performance upgrades for rebuilt assets
6. Ensure that owners retain title to properties
7. Identify location & number of people to be rehoused
8. Identify temporary housing needed
9. Identify types of available temporary housing
10. Establish local development organisations
11. Identify key community buildings needed
12. Establish a Skills Registry
13. Undertake research on wood-frame techniques
14. Segregate demolition wastes
15. Re-use debris to extent possible

A

Urgent Actions 5–10 years

Summaries of key steps by phase

B: Mid-term Actions 10+ Years

C: Long-term Actions 20+ Years

A: Urgent actions (5-10 years)

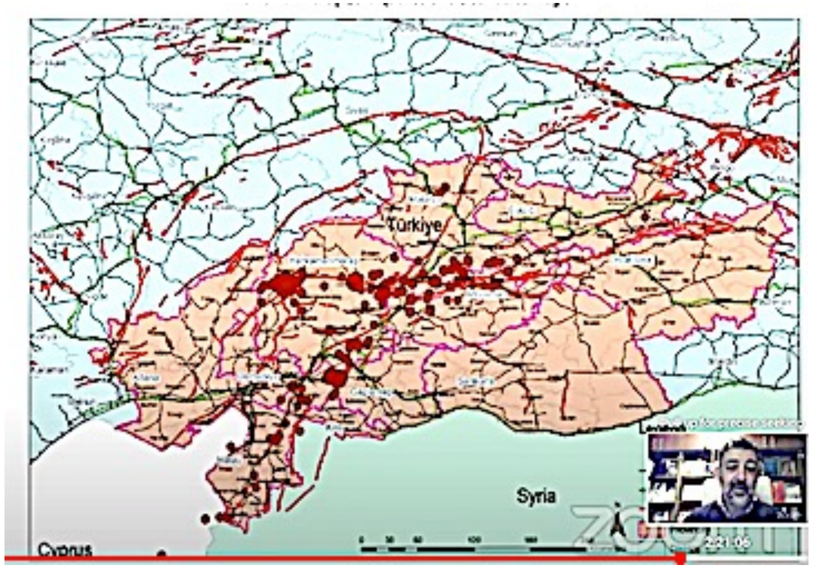
A.1 Prepare maps of urban areas affected by the earthquakes to show changes in active fault zones so that most sensitive areas can be avoided for future construction.

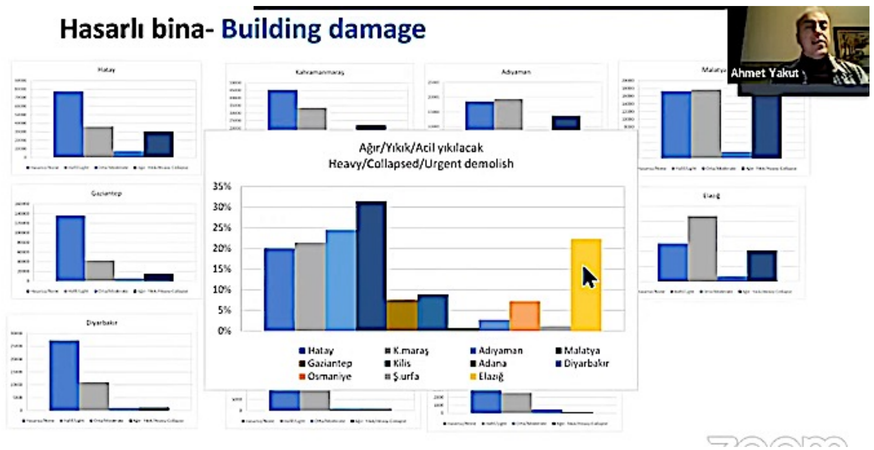
A.2 Review and identify weaknesses in current seismic regulations, mechanisms for implementation, quality assurance and feedback, using international experience for references.

A.3 Identify areas where reconstruction should be avoided because of local soil conditions or potential for flooding or wildfire.

A.4 Identify priority areas for reconstruction of infrastructure and buildings, while reserving areas of high ecological value to the extent possible.

A.5 Where buildings are to be reconstructed on or near to their original locations, assess the feasibility of improving orientation and inter-building spacing to improve long-term environmental performance.





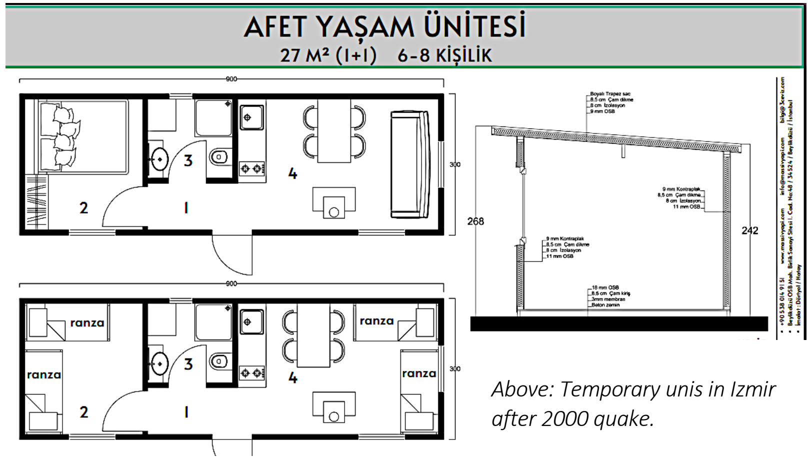
A: Urgent actions (5-10 years)

A.6 Ensure that owners of destroyed properties will be able to retain title to their properties.

A.7 Identify number, percent of population and household types without shelter who remain in affected areas and who want to be rehoused close to their area of origin.

A.8 Identify locations, type and number of shelters and housing units that may be needed for temporary housing during the next 5 or more years.

A.9 Identify types of temporary housing units that could be quickly made available for occupancy, by cost, origin, main materials (see also A14 and A15), design suitability, disassembly and re-use possibilities.



Above: Temporary unis in Izmir after 2000 quake.

Possible types include trailers, prefabricated modules or permanent structures that may be easily converted to other uses after the initial crisis is over. Where possible, temporary housing should be located adjacent to units that will require extensive repair or re-building, so that the temporary housing may also have a long-term use.

Below: Toilet and shower modules sent to Iskenderun

A: Urgent actions (5-10 years)

A.10 Establish local development organisations and traveling support teams to support rapid reconstruction.

A.11 In each priority area, identify key community buildings that need to be built, repaired or rebuilt by location, type; including primary and secondary schools, police stations, medical facilities, food shops …..

A.12 Establish a *Skills Registry* database, to identify individuals and firms in sensitive regions that have proven skills and expertise in key areas related to structural integrity, safety systems, recycling and re-use of materials, reconstruction, testing and commissioning processes.

A.13 Undertake research on wood-frame building types that will be suitable for housing and small education or commercial functions in Turkey.

Comments:

There are many individuals and small organisations that would like to rebuild their own damaged properties, but they may lack specialised skills or knowledge. Traveling support teams of individuals who can provide this type of support will provide a very useful service, while providing some assurance that these properties will withstand the next quake.

The development and maintenance of a national Skills Registry should be carried out by a non-profit and professional organisation.

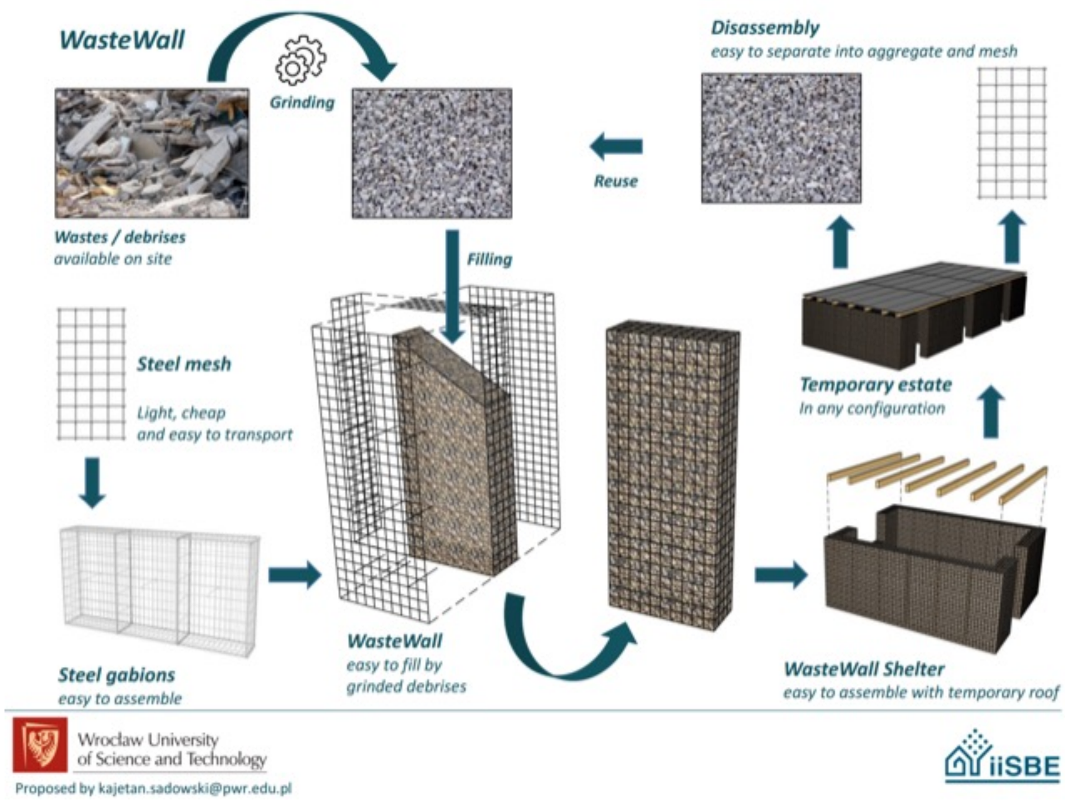
Timber is a renewable resource and wood structures can be designed to be constructed and later disassembled and re-used with a minimum of waste. Low-rise wood structures can also withstand stresses caused by moderate earthquakes. The use of wood frame is therefore an environmentally preferable choice in reconstruction of small houses, while Cross-Laminated Timber (CLT) construction should also be seriously considered for mid-rise residential, public or commercial buildings, to provide increased longevity at lower cost than reinforced concrete.

A: Urgent actions (5-10 years)

A.14 Segregate demolition wastes and identify those that can be reused as building materials, energy source or other resource. Take care in disposing of materials mixed with asbestos.

A.15 Re-use debris to extent possible according to Waste Wall principles, a proposal by Kajetan Sadowski* to help build temporary shelters by using building waste.

Since there is a lot of waste, it can be used to build temporary shelters until new shelters are built and the wastes are managed. Wastes from destroyed buildings are now a huge source of resources to be used and should not be wasted. All wastes/debris can be segregated and used, except for asbestos, in the best possible way according to their properties. The idea involves the use of debris of stones, concrete or bricks etc. to fill the steel mesh enclosure used as the walls of a temporary building. The mesh, as a light material, can be imported in large quantities from other countries, and the filling will provide some protection from the external environment.



* Kajetan Sadowski <kajetan.sadowski@pwr.edu.pl>

Key steps related to a sustainable reconstruction process in Turkey

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Damaging event(s)

A: Urgent Actions 5-10 Years

1. Rebuild or repair key water, sewer, transport, power and communication networks.
2. Repair or replace damaged or destroyed key public infrastructure.
3. Update earthquake resistance construction standards.
4. Upgrade structural and energy performance of existing buildings.
5. Use a synergy zone approach to balance excesses and deficiencies in thermal energy, renewable energy outputs or greywater in building clusters.
6. Design, construct and operate new buildings according high performance standards for life-cycle emissions.
7. Establish and maintain databases of actual operating energy and emissions.
8. Launch training programs to develop skills in high-quality and energy-efficient construction.
9. Provide small teams of traveling professionals to support self-build or self-repair.
10. Launch training programs for inspectors to certify conformance to construction quality and operating standards.
11. Continue to improve seismic regulations, mechanisms for implementation, quality assurance and feedback.

B

Mid-term Actions
10+ Years

Summaries of key steps by phase

C: Long-term Actions 20+ Years

B: Medium-term actions (10 years +)

B.1 Rebuild and repair road, electrical, communication, gas, water and sewer systems according to needs of a sustainable urban redevelopment plan, with an emphasis on supporting the quality of urban life, reducing energy consumption and GHG emissions, improving public transport and minimising use of private vehicles.

B.2 Repair or replace damaged or destroyed key public infrastructure, including power plants, district heating plants and water and sewage treatment facilities, railways and key roads.

B.3 Develop or update seismic-resistant construction standards for buildings of various heights and types.

B.4 Upgrade structural and energy performance of existing buildings, including improved seismic resistance, building envelopes and glazing.

In general, Turkish residential buildings have reinforced concrete structural systems. These reinforced concrete structures have several deficiencies, such as low concrete quality, non-seismic steel detailing and inappropriate structural systems including several architectural irregularities. In this study, the general characteristics of Turkish building stock and the deficiencies observed in structural systems are explained, and illustrative figures are given with reference to the Turkish Earthquake Code 2007. The poor concrete quality, lack of lateral or transverse reinforcement in beam–column joints and column confinement zones, high stirrup spacings, under-reinforced columns and over-reinforced beams are the primary causes of failures. Other deficiencies include weak-column–stronger-beam formations, insufficient seismic joint separations, soft-story or weak-story irregularities and short columns.

Cogurcu, M. T.: Construction and design defects in the residential buildings and observed earthquake damage types in Turkey, Nat. Hazards Earth Syst. Sci., 15, 931–945, https://doi.org/10.5194/nhess-15-931-2015, 2015.

Key infrastructure facilities are essential to the basic functioning of society in social, educational, health, commercial, industrial and public transport sectors.

Repair and reconstruction provides opportunities to combine some utility systems and to improve efficiencies.

A ZeroBuild organisation has been established in Turkey and will be a good source of guidance in this area. In the case of new individual houses, traditional design features that are compatible with local cultural values and traditions should be incorporated.

B: Medium-term actions (10 years +)

B.5 Synergy Zones:

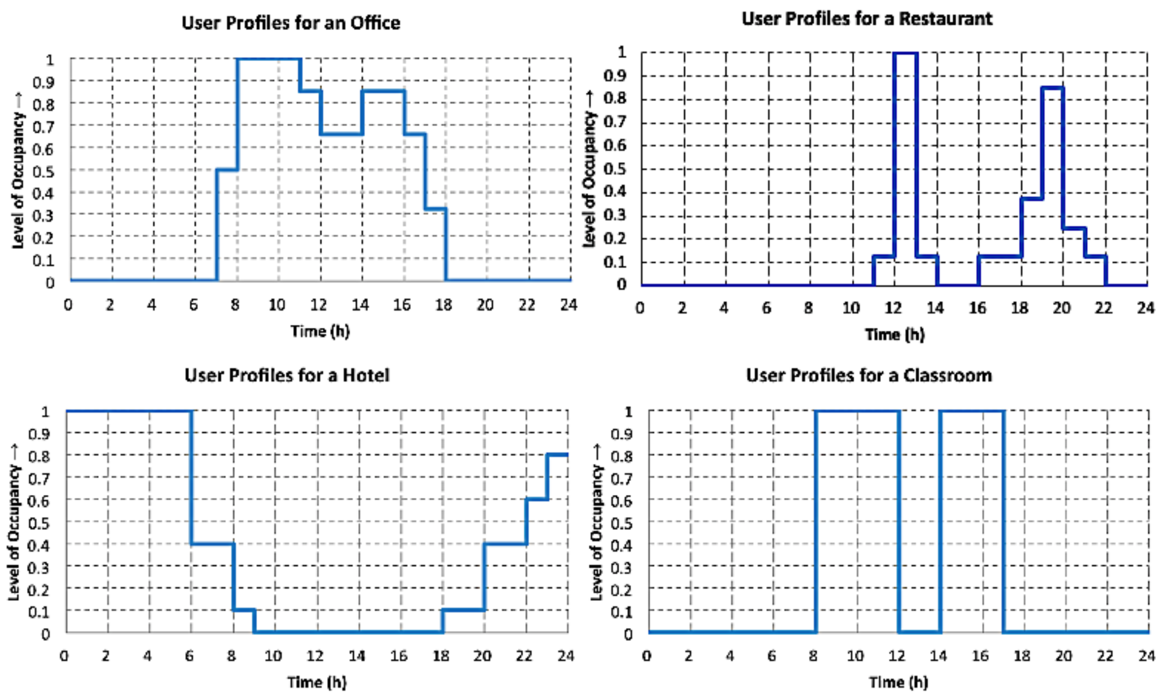
Office and public buildings with large internal areas relative to surface area will usually produce a surplus of thermal energy, while MURBS* tend to have a deficit during cold weather.

Daily peak energy demand for offices is the inverse of maximum demand for hotels, while restaurants and schools also have complementary demand schedules.

Multi-unit residential high-rise buildings (MURBS) tend to have small roof areas for collection of rainwater, but high demand for greywater, while schools have large roof and site areas with modest demand for greywater.

* MURBS = Multi-unit Residential Buildings

Diverse occupancy profiles provide opportunities



Source: Meli Stylianou, CANMET, NRCan, originally from BS EN 15232:2012: Energy Performance of buildings - Impact of building automation, controls and building management.

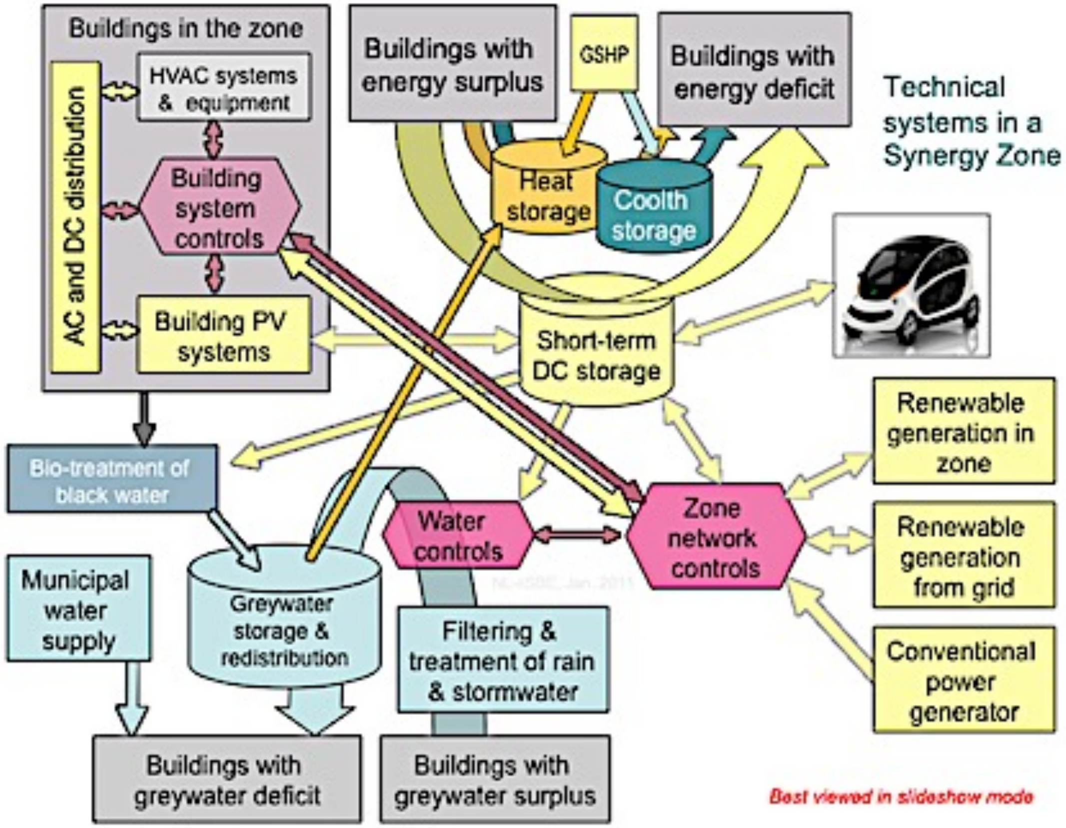
B: Medium-term actions (10 years +)

B.5 continued: Synergy Zones:

Where clusters of new buildings with different occupancies and configurations are located in close proximity, consider the use of a **synergy zone** approach to balance excesses and deficiencies in thermal energy, renewable energy outputs or greywater.

The diagram at right shows the generic relationships between generation, storage and distribution of surpluses and deficits for thermal energy, renewable power and greywater.

Optimising surpluses and deficits can result in considerable energy and cost savings, although management barriers must be overcome.



B: Medium-term actions (10 years +)

B.6 Where new buildings are required, they must be designed, constructed and operated according to very high performance standards for life-cycle emissions.

B.7 Establish and maintain public databases of actual operating energy and emissions of buildings and other structures.

B.8 Launch training programs for individual workers and small companies to develop skills in high-quality and energy-efficient construction.

B.9 Provide small teams of traveling professional advisors to support residents who are re-building their own homes.

B.10 Launch training programs for inspectors mandated to certify conformance to construction quality and operating standards.

B.11 Continue the process of reviewing, updating and improving seismic regulations, mechanisms for implementation, quality assurance and feedback.

Comment:

- Performance databases that are public and operated by a public or non-profit organisation can exert maximum positive influence on the building industry.
- Key content of training courses should include methods to maximise structural integrity, material selection to minimise use of non-renewable materials, high-performance building envelope design, effective ventilation systems, and integrated design process to avoid sub-optimal design solutions
- Improving quality control is of special importance in Turkey, where poor supervisionin the construction of multi-story buildings has been at the root of much of the damage to buildings

Key steps related to a sustainable reconstruction process in Turkey

Summaries of key steps by phase

Damaging event(s)

A: Urgent Actions 5-10 Years

B: Mid-term Actions 10+ Years

1. Identify likely demographic trends.
2. Minimize storm, flooding and wildfire potential through zoning limitations.
3. Develop strategies and plans for sustainable neighbourhood reconstruction.
4. Develop performance goals and targets for target neighbourhoods and buildings.
5. Allocate and protect land for leisure, aquifer replenishment, urban forests, wildlife and biodiversity.
6. Develop new infrastructure for low-temperature district heating systems (LTDH).
7. Identify capability of reconstruction plans to generate local employment.
8. Minimise use of non-renewable materials in new construction and make effective use of recovered materials for re-use or recycling.
9. Use third-party annual building inspections to control unsafe renovation and structural changes during occupancy.
10. Establish annual review of seismic regulations, mechanisms for implementation, quality assurance and feedback.

Long-term Actions 20+ Years

C

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C: Long-term actions (20 years +)

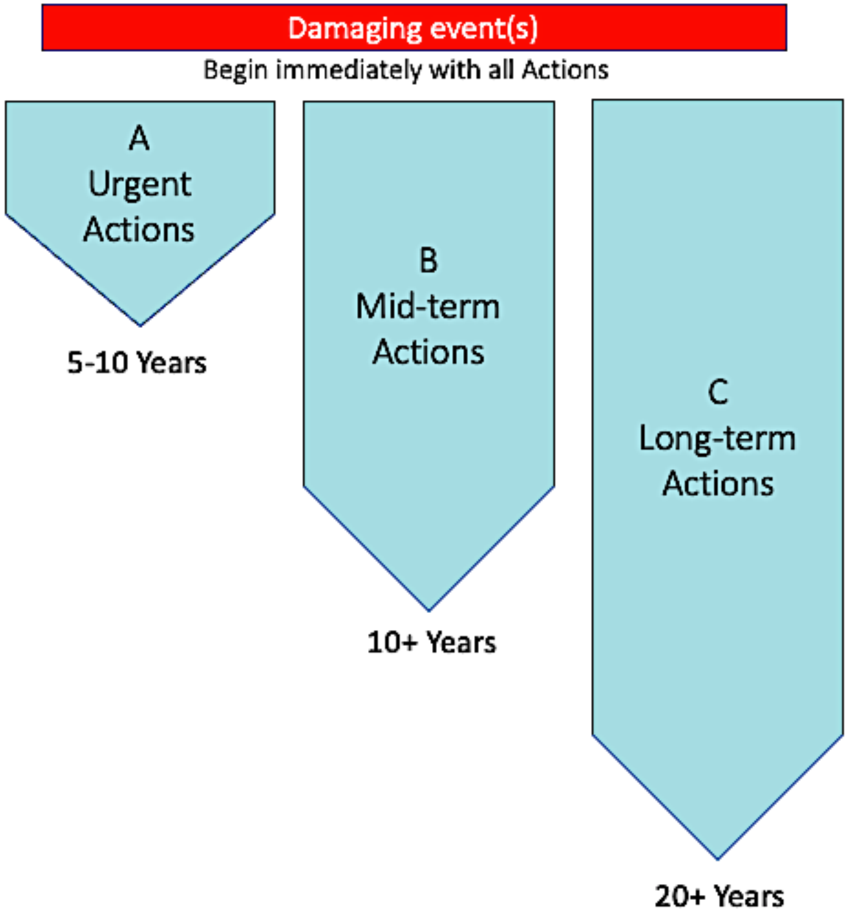
C.1 Identify likely demographic trends in affected regions that may affect reconstruction plans.

C.2 Develop plans for rebuilding sustainable, safe, low-emission, healthy, resident-friendly urban areas while also respecting traditions and cultural heritage.

C.3 Develop strategies and plans for sustainable neighbourhood reconstruction that follow low-carbon and green principles while providing safe, healthy and comfortable environment for local inhabitants.

C.4 Minimize storm, flooding and wildfire potential through zoning limitations of building location according to type.

C.5 Allocate and protect land for leisure, aquifer replenishment, urban forests, wildlife and biodiversity.



C: Long-term actions (20 years +)

C.6 Develop new infrastructure for low-temperature district heating systems (LTDH) to replace high-temperature DH systems (HTDH) and replace existing obsolete or destroyed HTDH systems with LTDH systems.

C.7 Identify the capability of reconstruction plans to generate local employment.

C.8 Minimise use of non-renewable materials in new construction and make effective use of recovered materials for re-use or recycling

C.9 Use third-party annual building inspections to control unsafe renovation and structural changes during occupancy by owners, tenants and occupants.

C.10 Establish annual review of seismic regulations, mechanisms for implementation, quality assurance and feedback with reference to similar processes in leading countries worldwide.

Comment:

- High-temperature district heating systems (HTDH) have been widely used to heat Ukrainian housing districts but less so in Turkey. In any case, they less efficient than newer low-temperature systems (LTDH).
- Earthquakes will cause the employment of local residents to be disrupted, but the reconstruction process provides opportunities to involve them to participate.

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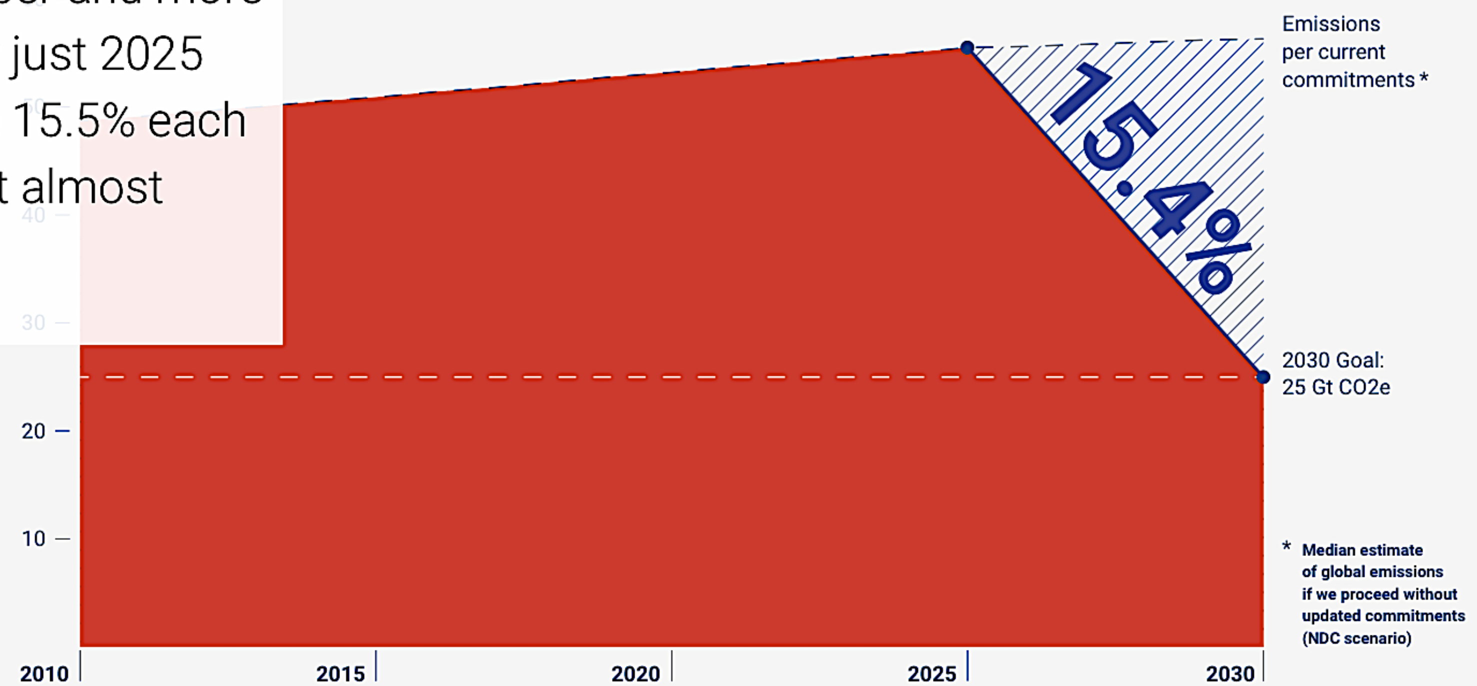
A reminder: Annual emission reductions needed by 2025 for a 1.5ºC maximum rise

Every day we delay, the steeper and more difficult the cuts become. By just 2025 the cut needed would will be 15.5% each year, making the 1.5°C target almost impossible.



Emissions Gap Report 2019, UN Environment

Context

Professor William Rees (UBC) is well known as the co-developer of the Ecological Footprint concept. In retirement he continues to pursue this area of inquiry and he has a number of conclusions that are relevant for an urban society that is trying to rebuild in a sustainable way.

Climate change is indeed a horrific prospect, but it is only one symptom of a greater truly existential threat, ecological overshoot...

Overshoot is therefore the cause of climate change and numerous co-symptoms including plunging biodiversity, ocean acidification, tropical deforestation, landscape/soil degradation, contamination of food supplies, depleting aquifers, the pollution of everything – i.e., virtually all other so-called environmental problems including the pandemic.

The ultimate goal should be a human population in the vicinity of two billion thriving more equitably in 'steady-state' within the biophysical means of nature.

Key points to consider

- The profit motive is dangerous as a main priority – it cannot be ignored but must be restrained by factors of public safety, professional standards and values, social and economic equity, and priorities of local populations.
- Professional skills and local knowledge are important.
- Insurance companies should be able to provide a good influence on the quality of planning and construction. If development firms are self-insured, an equivalent agency should take on this role.
- Priorities should be reconsidered – mixed uses, reduced incentives for private car use, emphasis on public transport, climate change impacts.
- Work in cooperation with other professionals (Integrated Planning and Design)
- Bad early decisions in planning and building design are hard to correct.

Key points to consider

- Work with nature (local ecosystems, tree shading, root structures etc.)
- Plan and design to allow future evolution and change
- Knowledge of local conditions and traditions is important
- Avoid sites close to quake zones and with unstable soils
- Take special steps to protect key public assets such as hospitals, schools, public transport hubs and cultural heritage assets
- Think about material alternatives: timber as alternative to concrete provides more structural resilience and makes it harder to disguise poor construction practices.
- Quality control is essential during construction and also long-term operations.

Appendix 1: Workshop in Izmir

Appendix 1: Workshop in Izmir

APRIL 26

Welcome speech – İlker Kahraman

Introduction, Prof.Dr. Ender Bulgun, Dean / Murat Aşkar, Rector of IUE

Current situation – Mustafa Özçelik, Head of Chamber of Architects Hatay Branch

Current situation – Hatay – Emre Uras, Architect, İskenderun Municipality

Current Situation Kahramanmaraş- Yunus Emre Kaçamaz – Head of Chamber of Architects Kahramanmaraş Branch

Current situation Malatya – Head of chamber of commerce and industry / Oğuzhan Ata Sadıkoğlu

Current situation Malatya - Yunus Emre Fidanel - Head of Chamber of Architects Malatya Branch

Current Situation İzmir – Chamber of City Planners

Lunch

Prof.Dr.Hüseyin Tarık Şengül, Middle East Technical University, Faculty of Economic and Administrative Sciences, Department of Political Science and Public Administration

Emin Yahya Menteşe, Orkut Murat Yılmaz, Description: Tomorrow's Cities Decision Support Environment (TCDSE)

Framework for sustainable Resilient Cities – Nils Larsson, Executive Director, iiSBE

Q & A

Sustainable Resilient City Planning workshop (Prof.Dr.Koray Velibeyoğlu + Res.Assit. Duygu Kahraman)

Closing Session- Forum

Appendix 1: Workshop in Izmir

APRIL 27

10.00 -10.40 Success Story of Chile … Cristián Alfredo Wittig Grell

This presentation deals with the importance for Turkey of analyzing the Chilean experience in developing regulations and administrative measures to deal with large earthquakes, tsunamis and recently, large wildfires.

Earthquake regulations of Turkey – Chamber of Civil Engineers

Importance of Soil - Prof.Dr.Hasan Sözbilir, DEU

Banu Dayangaç, Head of Izmir Metropolitan Municipality Earthquake Risk Management and Urban Improvement Department

Steps after October 30 Samos island earthquake, Halkyapı Example , Özge Kırlıoğlu, Ege Şehir A.Ş. Genel Müdür Yardımcısı

WOOD BUILDINGS

Wood buildings legislation – Prof..Dr.Ahmet Türer (METU)

Wood Buildings – Prof.Dr. Ario Ceccotti

Robert Jockwer, Associate Prof. Dr., Division of Structural Engineering, Chalmers- (online)

Murat Morel, Project Field Coordinator, UNDP, “Türkiye’de Düşük Maliyetli Enerji Verimli Ahşap Binaların Teşvik Edilmesi Projesi”

Appendix 1: Workshop in Izmir

Wood Building examples , Mehmet Akif Asmaz, Asmaz Ahşap,
Wood Building examples, Himmet Erbay, Naswood
Closing / Forum

APRIL 28

Temporary shelter design marathon. (All day)

Temporary shelters to be built here with at least 10 years in mind, to serve different families during the renovation period,

It is aimed that these structures will turn into a structures in the city periphery as villages. It will be taken into account that the construction of the structures will be quite simple and will have a low cost. It is desired to create an environment where the wounds will be healed together.

The design teams will be formed with the invitees, especially from İzmir, and an answer will be sought to the above-mentioned problem in the company of the executives.

İlker KAHRAMAN
Head of Chamber of Architects İzmir Branch
–Lecturer at İzmir University of Economics,
Management committee member of İİSBE

Appendix 1: Lessons from Chile

Text by Cristian Wittig, Santiago Chile

1. Chile is, by far, the most seismically active country in the world

2. From 1570 to date Chile has resisted and survived 108 large earthquakes and tsunamis.

3. Chile has the record for the largest number of severe and extremely severe earthquakes among all seismic countries.

4. Chile has the highest number of recorded severe earthquakes above 8.0 (Mw).

5. Chile has the record of having suffered (and survived) the largest Mega earthquake recorded in human history: Valdivia 1960, with 9.5(Mw) and 10 minutes long, together with a tsunami that devastated more than 1,000 km of the national coast.

6. Chile's most recent large registered earthquakes were in 2010 (8.8 Mw), in 2014 (8.2 Mw) and in 2015 (8.4 Mw).

7. Between 1906 and 2016, Chile has suffered, resisted and survived 78 earthquakes over 7.0 (Mw), that is, in 110 years it has suffered major earthquakes every 1.4 years!

- 109 Earthquakes (1570 – 2016)
- 25 Earthquakes above degree 8.0 (Ms and Mw)
- 84 Earthquakes above degree 7.0 (Ms and Mw)
- The largest Mega-Earthquake recorded in human history: Valdivia 1960, with 9.5(Mw)

Appendix 1: Lessons from Chile

Text by Cristian Wittig, Santiago Chile and Nils Larsson, iiSBE

Chile has implemented a four-fold strategy to maximise resilience of buildings and other structures:

1. The development of a comprehensive, multidisciplinary and interconnected set of seismic regulations, designed to be applied to all construction activity within the country.

2. The establishment of a powerful, effective and efficient central institutional agency, provided with the national responsibility of implementing the full application of seismic regulations for all construction activity, reviewing the results of their use and of modifying and updating them.

3. Establishment of independent and non-profit agencies, linked to national universities with world-class qualifications in structural design and performance for seismically sensitive zones, to develop and establish quality certification protocols for all materials, processes and construction methods used in Chile.

4. The formation of high-quality technical and professional teams in each of the country's municipalities with the following responsibilities:

- to review architectural and structural engineering plans for all projects within the municipalities,
- to grant or reject building permits with respect to compliance with the current regulations,
- to require the involvement of independent Structural Calculation Reviewers,
- to monitor the construction quality of these projects,
- to ensure the certification of materials, protocols and processes related to each project.

Appendix 1: Lessons from Chile

Text by Cristian Wittig, Santiago Chile

Chilean Seismic Strategy

1. Buildings should be designed and constructed for a useful life between 50 to 70 years, to resist large earthquakes, to suffer damage, but to never collapse.
2. Structures can be damaged, and even require demolition after an earthquake, but structures must not collapse during a severe earthquake.
3. Establish a balance between a construction cost that protects against collapse and a low probability of an extremely severe seismic event.
4. This philosophy guarantees the preservation of human lives, along with optimizing the use of society's economic resources.

Chilean Strategy for Seismic Resistance

1. There are two concepts of great importance in Chilean seismic design: Lateral Resistance and Ductility.
2. Lateral Resistance refers to the horizontal resistance capacity that a structure is capable of developing before collapsing.
3. Ductility reflects the energy absorption and dissipation capacity that a structure can offer before collapsing.
4. The structures must, in one way or another, dissipate the energy that the movement of the ground manages to transfer during an earthquake.

Appendix 1: Lessons from Chile

Text by Cristian Wittig, Santiago Chile

Chilean Strategy for Seismic Resistance

5. The most effective way to carry out this task during earthquakes of great severity is by deforming laterally and experiencing local deterioration of the material in which energy is converted into heat. Certainly these deteriorations imply internal damage.

6. If during this process, it is not possible to develop the horizontal deformation that leads the structure to its collapse, it will survive the seismic event; otherwise, it will collapse.

7. The maximum deformation that the severe earthquake demands of a structure is expressed through Ductility, which is the coefficient between the maximum deformation and a reference horizontal deformation (Yield deformation).

8. Seismic experience indicates that to have a satisfactory seismic behavior, the design must ensure that the structure has a high lateral resistance, if it does not offer a ductile behavior, or a sufficient ductility for the lateral resistance with which it has been designed.

9. As the structure is designed with higher Lateral Resistance, the lower the need for Ductility, and vice versa.

10. Both features involved in the design are related, and the collapses that occur are generally associated with poor ductility provision for the lateral resistance that has been considered in the design.

Appendix 1: Lessons from Chile

Text by Cristian Wittig, Santiago Chile

Chilean Strategy for Seismic Resistance

11. This has been, added to other factors (Regulations and Guarantor Institutionality) the great differentiating element that largely marks the success of Chile in its process of mitigation and urban resilience in the face of severe and extremely severe seismic events.

12. The Chilean experience, which until now has differed from that used in most countries in the world, has chosen to provide High Resistance and low or moderate Ductility.

13. This experience has been very successful in the face of severe seismic events, such as the one that occurred in March 1985 in the central zone of Chile and in the great earthquake of 2010 in the South Central Zone of the country.

14. On the contrary, the method of providing a High Ductility associated with a low or moderate Lateral Resistance, as advocated in countries such as Japan, Mexico, New Zealand, USA and many others, has turned out to be very ineffective.

Appendix 1: Lessons from Chile

Text by Cristian Wittig, Santiago Chile

Conclusions

1. From the seismological point of view, one of the most valuable lessons of earthquakes is related to the information that allows us to evaluate the behavior of our buildings on a natural scale against real loads.

2. Give priority to the management and application of the concepts and relationship of Lateral Resistance and Ductility in structural calculation projects

3. Historically, buildings in Chile have been increasing their good performance in the face of the different events that have occurred in the history of our country, mainly due to the improvements and advances that are being generated in design and construction regulations.

4. The Seismic and Construction regulations in Chile have been in constant evolution, through a process of continuous improvement over time.

5. The construction of a profound national seismic culture, which begins in primary education, with a transformation in the demands placed on students of architecture and urban planning, fostering a close relationship with structural engineers.

6. Avoid or make the possibility of corruption in the construction process as complex as possible, forcing the involvement of many independent actors: independent reviewers, academic institutions for oficial materials certification laboratories, technical quality bodies in the municipalities and a general control entity that oversees for unrestricted compliance with these procedures.

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