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A COMPREHENSIVE MODEL FOR EARTHQUAKE RISK REDUCTION IN TURKEY

Pelin GUNDES BAKIR[1]
Hasan M. BODUROGLU[2]

SUMMARY

This study presents a comprehensive model for earthquake risk reduction in Turkey. Earthquake risk reduction strategies are discussed within the context of the technical, legislative and economic aspects of mitigation in Turkey. Several proposals for improving the current legislative structure in Turkey are given. Common technical problems of the Turkish existing building stock are discussed. Strategies for mitigating and retrofitting the existing building stock are proposed both at the macro and micro level and alternatives for financing the catastrophe risk in Turkey, such as transferring the catastrophe risk to capital markets, are also examined. The main emphasis in this paper will be on the legislative, economic and technical aspects of mitigation whereas the political aspects are only briefly described.

INTRODUCTION

Kocaeli and Duzce earthquakes hit Turkey in 1999 and their magnitudes were 7.4 and 7.1 respectively according to USGS [1]. A previous paper of the authors [2] gives a good account of the Marmara earthquakes, lessons learned from these earthquakes, and the proposals for response, recovery and preparedness as well as planning phases of disaster management in Turkey. There are many important lessons to be learned from Turkish earthquakes, as many of the constituents of these catastrophic earthquakes such as rapid urbanisation and industrialisation, migration and squatters, income difference between different regions of a country, problems related to construction industry and insurance sector are present in other parts of the world such as Latin America, Portugal, Eastern Europe, North Africa, Israel and some parts of Middle East. The objective of this paper is to present a detailed national strategy for risk reduction. It should be noted that little will be accomplished without legislation and the legislation needs to be supported by technical provisions. For this reason, the main emphasis in this paper will be on the legislative, economic and technical aspects of mitigation whereas the political aspects are only briefly described.

[1] Istanbul Technical University, Visiting Researcher, Katholieke Universiteit Leuven, gundes@itu.edu.tr,
[2] Professor, Istanbul Technical University

LEGISLATIVE ASPECTS OF MITIGATION

The Laws that are going to be discussed in this paper are Governmental Decrees 4708, 587 and the new Public Procurement Law #4734 (Official Gazette [4],[5],[6],[15]). These laws contain many inherent weaknesses and there are many difficulties in implementation of these laws. The former disaster law #7269 (Turkish Laws), is discussed in detail in a previous paper of the authors [2] whereas the Development Law # 3194 and a detailed proposal for a National Mitigation Strategy in Turkey is discussed in another paper of the first author [15].

The governmental decree #4708

On July 13th 2001, Governmental Decree 4708 was issued. The new decree requires the Construction Supervision Firms to control constructions. The new decree is in use in 19 pilot provinces and has the following weaknesses:

- The law does not require the engineers of the Building Supervision Firms to be Chartered Engineers.
- The certificates of all the Building Supervision Firms in Turkey are given by a commission consisting of only five members located in the capital Ankara. Within this respect, the building supervision system in Turkey is highly centralised in nature.
- The new decree does not require a chief engineer to be present during constructions [7,8,9].
- The decree does not cover public buildings.
- The new law has made the Building Supervision Firms, contractors, laboratory staff testing the materials, and control engineers all responsible from any damage occurring. The sharing of responsibilities will make the legal sanctions ineffective [7,8,9].
- The maximum building supervision services that the Building Supervision Companies can give is based solely on the construction area in the Building Supervision Implementation Regulations. This inevitably leads the firms to get more buildings with smaller construction areas rather than few buildings with larger construction areas. The increase in the number of buildings to be supervised reduces the supervision quality.

Proposals for change within the Governmental Decree #4708 are explained below:

- A chartered engineering system should be initiated. The professional engineering certificates should be given by The Chambers of Civil Engineers upon the satisfaction of the following; attending a specific course, passing an examination made by Higher Education Council of Turkey, work experience of at least 5 years in the related field.
- The statements in the law, makes it ambiguous who to blame if a supervised building collapses in a catastrophic earthquake. The law gives the impression that it ensures the sharing of the responsibility by as many stakeholders as possible. If the Building Supervision Firms do not insure themselves, it is not clear how they will finance the possible collapse of the buildings they supervised. It is also not clear how the problem of insolvencies of the building supervision firms will be dealt with. For this reason, the financial and professional responsibility insurance for Building Supervision Firms as well as Contractors should be made compulsory in Turkey and the premiums collected should be transferred to a fund, a certain proportion of which can be used for mitigating the existing building stock.

- The Building Supervision system should be decentralised in order to increase the quality of supervision. The personnel and technical resources of the Building Supervision Commission should be increased and these commissions should also be established in cities and districts.
- The governmental decree # 4708 is in use in only 19 pilot cities in Turkey. The recent 6.2 M Afyon earthquake in 2002 showed that the governmental decree should be in use in all cities of Turkey immediately. Afyon was not a city that the governmental decree was in effect however, there was a high dead toll and high material damage in this earthquake.
- The law should be amended such that the decree should cover the public buildings as well. The recent 6.4 M Bingöl earthquake in May 1, 2003 showed that much of the damage in the city was concentrated in public buildings especially in schools. The schools (Bingol Liseum, Mehmet Akif Primary School, Anatolian Art Liseum), police offices and telecom buildings were heavily damaged. The greatest dead toll was in the pension building of a boarding primary school- (Celtiksuyu Boarding School) in which 84 children died under the totally collapsed pension building of the school .

The governmental decree #587

Since the Erzincan earthquake in 1992, World Bank has been an organisation to which the Turkish officials frequently applied for post-earthquake assistance. These funds were not efficiently and economically used by Turkey however, and they were perceived as a financial tool to provide new homes for disaster survivors at no cost. With the pressures from the World Bank, in 27th of December 1999, a decree # 587 abolishing the former guarantee of the government for the replacement of the collapsed houses was announced. The decree [4] stipulated a compulsory earthquake insurance for residential buildings and offices. Instead of providing new homes for the collapsed ones, the government formed a Turkish Catastrophic Insurance Pool. 17000$ coverage would be provided for each house. Coverage in excess of this would be supplied by private insurers. Natural Disasters Insurance Agency is established according to this decree. The new system has the following weaknesses:

- There have been four years now that the Compulsory Earthquake Insurance Decree is in effect. However, the insurance penetration is still quite low (14% in Turkey general-Radikal newspaper [11]). For instance, in the last Bingol earthquake, it was announced that 98% of the houses in Bingol area were not insured by Compulsory Earthquake Insurance (CEI). There should be a strong political will to enforce the Compulsory Earthquake Insurance(CEI). Soon after the Bingol earthquake, the government announced that new homes would be constructed by the government for those families whose buildings were damaged in the earthquake regardless of their participation in the Compulsory Earthquake Insurance (CEI). This discourages the penetration of CEI and is unfair to citizens who have paid the CEI premiums. One of the causes of the low CEI penetration in Turkey is the low levels of public awareness among citizens. The citizens should be informed that only those citizens who have paid the CEI premiums would be eligible for receiving the $17000 coverage and the governments will not replace the damaged houses with new housing. There should be penalties in the law for those citizens who do not insure their buildings according to CEI.
- The CEI does not address or encourage mitigation. The premiums to be paid are not proportionate to the risk levels concerned and are only based on the cross-sectional area of the residence [8]. The decree should be modified such that the premiums paid by the owner of an earthquake resistant building should be lesser than premiums paid by the owner of a non-engineered building. The premiums for a retrofitted building should also be significantly lower than one needs retrofit.

The Procurement Law #4734

Procurement of goods, works and services for the public sector represents 20% of Turkey's GDP (Radikal, [12]). Procurement represents only 15% of GDP in European Union. An assessment of the Bingol and Pulumur earthquakes showed that one of causes of the devastation in these earthquakes was the heavy

damage in the public buildings such as schools, liseums etc which revealed the weaknesses of the Turkish Public Procurement System. Until 2002, the procurement of the public buildings was carried out according to Procurement Law #2886 [3] which was enacted in 1983. The former procurement system had the following weaknesses as discussed in more detail in a previous paper of the first author [15]:

- Lack of transparency in the bidding process and lack of accountability of the public officials,
- Lack of an agency for public procurement and lack of a complaint or protest mechanism,
- Absence of competition. According to the former law, foreign companies could not participate in the bids,
- The time period between the opening of the bid and the advertisement was very short,
- The bidding procedures that the law allowed were sealed bidding procedure, selective restricted tendering, negotiated procedure, competition and public bidding. The open tendering was a fair and transparent method however, the selective restricted tendering and public bidding were also frequently used which resulted in unfair applications and severe corruption. According to the selective restricted tendering, the relevant government agency prepared a list of contractors and invitations were only made to these companies. This was the preferred method in many public entities,
- Bidders were not allowed to modify their bid or take back their bid before the deadline [13],
- There was lack of fair price adjustments and slow payments to contractors,
- A single bid was divided into several smaller parts so that it did not exceed the threshold values. These threshold values were important because if these values were exceeded, the bids had to be controlled by the Turkish Court of Accounts. By this way, the bids were made free of Turkish Court of Accounts' control,
- The former law did not cover State Economic Enterprises (SEE). Thus, the preferred bidding method for the SEEs was the restricted selective tendering, in which the participants were invited by the relevant agency. Some bids were even not publicly advertised which caused corruption and bribery.
- The previous public procurement system relied on the carnet (Contractor Certificate) system. In the carnet system, the contractors were given certificate types from A to H by the Ministry of Public Works and Settlement, in which A was for the large scale bids and H was for the smallest. The carnets were given according to companies' financial capacity, technical resources and personnel. The public officials could also be qualified for these carnets, higher authority public officials could even obtain type A carnets [13]. The logic behind this was that after retirement from Public Civil Service, the public officials could find ways to use their experience in private sector. However this often resulted in misuse, as the owners of these A type unlimited carnets, often sold or hired these carnets to Contractors or Construction Companies. Many construction companies obtained these carnets not by qualifying for these but by buying these carnets from public officials. When awarded with contracts, these companies produced constructions such as primary schools, hospitals, and other public buildings which were of very poor quality.
- In the previous system, the bidders were asked to present their offer as discounts against pre-determined contract value [13]. This was one of the causes of devastation in the last earthquakes. The general application of this system in Turkey was that bidders could decrease 40 to 50% from the predetermined contract value. When awarded, they either could not complete the projects or they produced very poor quality construction.
- There was lack of contract supervision or control during the implementation of the projects.

- Preference was given to contractors from particular regions, or particular ethnic background. For instance, the pension building of the Primary Boarding School in Celtiksuyu, Bingol which collapsed and killed 84 children was constructed by a company whose owners were from Bingol. During the construction phase, the inspections showed that the company performed poor construction but the National Education Ministry did not penalise the company (Radikal, [14]). Due to the protracted faulty acts of the owners, the company was eventually prohibited from participating in the public bids for two years in 2002. Regionalism, ethnic or political favourism were inherent parts of the former Public Procurement System in Turkey.

The new law #4734 brought many improvements in the Turkish Public Procurement System. Some of these are listed below:

- The carnet system is abolished.
- The bid preparation time is increased.
- The new law covers State Economic Enterprises which is a huge step in mitigating the procurement system.
- The new law does not allow the bids to be divided into many smaller parts .
- The bidders are allowed to make any modifications before the deadline for bid submission.
- The law requires the establishment of a Public Procurement Agency which will be an independent, de-politicised organisation. The agency is made responsible for inspecting any complaints against the procurement entity.
- The new law presents procurement as a profession to the Turkish Civil Service System.

The new law can be improved in many ways. The proposals of the authors are listed below:

- All of the public bids should be auctioned by Public Procurement Agency.
- Negotiated procedure, or selective restricted tendering should be avoided altogether except for disasters. The only allowed method for other types of bids should be closed form tendering.
- The existing law is only based on cost. The bid is awarded to the most advantageous offer in terms of price. Technical merits of the projects are not taken into account. The law can be amended such that the technical merit of the projects are also inspected by the Public Procurement Agency.
- An international telephone or e-mail address can be provided to the bidders so that any corruption can be reported without delay. The Public Procurement Agency should have a newspaper or bulletin which announces all of the public bids in the country. The bids should also be announced in the web page of the Public Procurement Agency.
- The bidding procedure should be in three stages. In the first stage the offers should be investigated in terms of price. In the second stage a post qualification evaluation should be applied to the bidder with the lowest offer. The bidder should be inspected by use of objective criteria such as financial capacity, similar experience, technical resources and qualified personnel. In the third stage, the detailed technical drawings and the detailed project should be inspected.
- The implementation of the public bids should be controlled and supervised by independent private consultant companies which report to Public Procurement Agency.
- Professional Responsibility Insurance should be made mandatory for consultant companies and contractors.

4. Economic aspects of mitigation in Turkey

The authors are of the opinion that the success of earthquake hazard mitigation in a country depends on the strength of its economy [15]. Much of the devastation observed in recent earthquakes in Turkey could have been prevented if Turkey had a strong economy. Thus any mitigation program initiated in a country should recognize this and should consist of the essential ingredients for successful change in this direction. Turkey is a country with a young population, high growth potential and a country located at a highly strategic region constituting a bridge between Asia and Europe and close to Middle East and emerging economies in Central Asia. Although Turkey is the world's 17th most industrialized nation, it unfortunately ranks 85th out of 173 countries in terms of Human Development Indicators, as measured by UNDP in 2002 [16]. Throughout nineties Turkish economy generally showed mini cycles of growth-crisis-stabilization and revived synthetic development. The authors are of the opinion that the devastation, loss of life and material damage to property in the recent earthquakes may have resulted due to the persistent problems of Turkish economy such as high inflation rates; national patterns of poverty which gave rise to migration to illegal settlements in the country's major economic centers, corruption, political instability due to prolonged coalition governments, the poor banking system, and the lack of cost-effectiveness of the State Economic Enterprises (SEEs), to name a few [17]. Privatization has a critical role in earthquake mitigation in Turkey as it can transfer the risk of financing disasters from the government to the private sector. One of the priorities in Turkey should be to develop a Private Sector Sustenance Strategy. The authors are of the opinion that for Turkey, the risk of loss from earthquakes may be more efficiently shouldered by the private market. The losses caused by earthquakes to the infrastructure have generally been shouldered by governments as the governments were assumed to be the best entities to sustain the cost of post disaster reconstruction by their power of taxation. Furthermore, it is presumed that governments can diversify risk according to the law of large numbers. According to this theory, the risk is spread over large populations and larger geographical regions by the governments through taxation. This is the strategy used in US as, the government sustains the risk of natural hazard losses in the privatization process in the energy activities in US (Department of Energy US, [18],[19]). In developing countries on the other hand, this strategy is not strictly true because the risk of loss from catastrophes are generally correlated. In Turkey for instance, the major industry is located in one single area, the Marmara region which is the most vulnerable region in Turkey against earthquakes. In addition, forty-three percent of Turkey's population live in potentially catastrophic disaster regions. For this reason, the earthquake risk is highly correlated in Turkey. Managing the catastrophes in Turkey through taxation has also a high political cost. At times of disasters, Turkey has generally faced difficulties in allocating internal resources, external debt has generally been the favored choice as it has the least political price. But due to the budget considerations, the earthquake losses in Turkey should be transferred to investors as a component of the privatization process. This would also inevitably encourage mitigation activities or transfer of risk through insurance.

Alternatives for hedging catastrophe risk: Capital market solutions

Insurers and reinsurers play an essential role in pooling individual property risks through portfolio diversification principles. However, in Turkey, there is not an active private insurance market for earthquake risk. Furthermore, the occurrence of very large scale catastrophic disasters in the world recently raised questions whether the property insurance industry would have sufficient capital to pay all claims in these kinds of disasters. In Hurricane Andrew in US for instance, there were $16 billion insured losses and nine insurers became insolvent, while in the Northridge earthquake, one major regional insurer almost failed and had to be recapitalised (EERI, [20]). In 1992, when Hurricanes Andrew and Iniki struck, a record sixty-three property/casualty insurers became insolvent (ISO, [21]). It is well known that government, with its power to tax may be able to provide the necessary financial support for large scale catastrophes but the above-mentioned crisis brought up questions whether alternative market mechanisms could also absorb some of the risk. In this case, transferring risk to capital markets can be a good solution. A study carried out by Swiss Re [22] showed that even a $100 billion insured loss could easily be absorbed by $26 trillion capital market as the daily volatility in market valuation exceeds $130 billion.

A cat bond obliges an investor to put money up front, which may be used to pay for claims if some type of catastrophic event were to happen. In response to this commitment of funds, the investor gets a higher interest rate in time periods during which no disaster occurs. Cat bonds are not correlated with the market, thus they are perfect tools for portfolio diversification. They are also very attractive for the insurers as they have more expeditious payoffs in contrast to the slow payment of money from reinsurance. Kunreuther [23] suggests that cat bonds can cover multiple risks and may combine several uncorrelated hazards so that the risk can be diversified. This way, both the insurers and the investors can benefit. The insurers takes advantage of the improved exposure management as a result of geographical diversification. The investors on the other hand, have a smaller chance of losing a given amount of principal due to the uncorrelation of risks in different regions or across different types of hazards. The typical example to this kind of cat bonds is the three year multi-peril cat bond issued by a French reinsurer SCOR which covers Japanese earthquakes and cascading fires, US earthquakes and European wind storms in seven different countries. The authors are of the opinion that the feasibility of a multi-peril cat bond in Turkey, for instance covering hurricanes, floods or tornados in Mediterranean region, earthquakes in Northern Anatolian Fault and floods in Black Sea region or forest fires in Aegean region must be examined and the impact of such a parametric cat bond on the reduction in insolvency probability of the insurer as well as the risk to the investor should be investigated. In countries which have financial problems in providing for the interest on the cat bond, Kunreuther [24] suggests that World Bank can play an important role. World Bank can buy these bonds from the country at a subsidised rate and then issue them to private investors at a higher rate [24]. This could be an ideal solution for Turkey as well. The purchase of cat bonds by the World Bank will provide a solid guarantee and a feasible solution. These funds can then be used in the post disaster reconstruction as well as mitigation activities. This would also prevent the foreign investors from demanding very high interest rates from Turkey.

Technical Aspects of Mitigation in Turkey

After the Marmara earthquakes in 1999, three significant earthquakes occurred in Turkey. According to USGS the magnitudes of these earthquakes were 6.5 in Afyon-Çay earthquake (February 3, 2002), 6.1 in Pulumur earthquake (January 27, 2003) and 6.4 in Bingol earthquake (May 1, 2003). Many of the constituents of the Marmara earthquakes were present in Afyon, Pulumur and Bingol earthquakes. The causes of structural damages in these earthquakes are briefly summarised as below:

- Inadequate design of pre-cast concrete structures [25],
- Irregular buildings,
- Absence of transverse reinforcement in columns or beam-column joints, (transverse reinforcement improves the joint performance significantly, (Bakir PG and Boduroglu H, [15,26,28,29])
- Corrosion of reinforcement,
- Faulty projects such as weak columns and strong beams or slabs,
- Hollow bricks for infill walls instead of shear walls,
- Poor concrete quality [30],
- Short columns.

Lessons learned from these earthquakes show that seismic rehabilitation of the existing building stock and infrastructure remains the most important problem for earthquake hazard mitigation in Turkey. The seismic rehabilitation problem is difficult, yet, not impossible to solve [36, 37]. Proposals for seismic rehabilitation of the existing building stock and infrastructure are listed below as given in a previous paper of the first author [15]. On the macro level:

- The governments can reduce the tax of the retrofitted buildings and demand higher tax for the buildings that are most likely to be damaged. In other words, the tax should be based on the risk level of that particular building. This would to a great extent encourage mitigation. Furthermore, some portion of this tax can be used for financing the mitigation activities.
- In Turkey most of the buildings are illegal. There is mass migration from the countryside to the urbanised areas and the new comers occupy land which belongs to the state. They build apartments or squatters without any permission at all. The government is planning to announce a development amnesty and sell these occupied lots, which were once forests, to the occupiers in order to rehabilitate these illegal districts. The author is of the opinion that this can be an important opportunity for mitigating the existing illegal building stock. The squatters should only be given their deeds if they can provide a certificate showing that the building is inspected against possible damages from earthquakes. This inspection should be carried out by private companies which are authorised by the Ministry of Public Works and Settlement and their activities should be strictly controlled by the Ministry. If the inspection certificate shows that the building needs retrofit, the squatters should only be allowed to obtain their deeds if they retrofit or strengthen their building. If it is not feasible to retrofit the building, the building should be demolished.
- Turkey has recently reformed and improved the banking system under the governance of IMF, which has carried out a severe disinflation program in Turkey. Weak banking system and high inflation were the main causes of the prevention of the development of a mortgage market in Turkey. With the new reforms, the banks can now provide funds for mitigation with a pay back period equal to the life of the mortgage. This could be backed up by reductions in insurance premiums. Similarly, the banks may demand the sellers to retrofit their buildings. They can also state that unless this is done, they will not provide the funding.
- In Turkey, there is no existing code for retrofitting the existing building stock. One of the priorities in Turkey should be to prepare this retrofitting code. The author is of the opinion that in the new code, greater flexibility is required than in the design of new buildings and the rules should be general. The code should favour nonlinear methods over linear and displacement based approaches to force based approaches. The reason behind displacement–based approaches is clear. In reality, the earthquake does not demand the structure to resist a set of given forces as assumed in the force-based methodologies, but demands the structure to resist a set of dynamic ground displacements. It should also be noted that structures do not collapse due to earthquake lateral loads but due to P-Δ effects originating from gravity loads. Thus it has been proposed by Moehle [31] that the displacement based approaches are more rational than the force-based approaches. The code should include a commentary and short courses should be initiated on the seismic rehabilitation of the existing buildings. More importantly, the code should be legally enforced.
- The possible earthquake losses in the infrastructure in Turkey can be transferred to investors as a component of the privatisation process: The essential urban and rural infrastructure are substantially affected from earthquakes. In US, more than half of the expenditures of the FEMA (Federal Emergency Management Agency, [35]) is spent on reconstruction of the infrastructure (USA Today, [32]). The losses caused by earthquakes to the infrastructure have generally been shouldered by governments as the governments were assumed to be the best entities to sustain the cost of post disaster reconstruction by their power of taxation. In developing countries on the other hand, this strategy is not strictly true because the risk of loss from catastrophes are generally correlated (Freeman,[33]). In Turkey for instance, the major industry is located in one single area, the Marmara region, which is the most vulnerable region in Turkey against earthquakes. In addition, forty-three percent of Turkey's population live in potentially catastrophic disaster regions. For this reason, the earthquake risk is highly correlated in Turkey. Managing the catastrophes in Turkey through taxation

has also a high political cost. At times of disasters, Turkey has generally faced difficulties in allocating internal resources, external debt has generally been the favoured choice as it has the least political price. But now in 2004, the budget deficit is an important problem and the earthquake losses in Turkey should be transferred to investors as a component of the privatisation process. This would also inevitably encourage mitigation activities or transfer of risk through insurance.

- There are many problems in retrofitting the existing building stock. The first one is that the current legislation requires the existing buildings to be retrofitted according to the New Earthquake Resistant Design Code [34] level. It is very clear that this is a very uneconomical solution. The authors are of the opinion that a performance based approach should be adopted for seismic rehabilitation of existing buildings in Turkey. The performance levels for buildings should have alternatives such as operational level, immediate occupancy level, life safety level and collapse prevention level. A quick rapid inspection of the existing building stock has to be carried out first. Then the buildings which were evaluated as most risky ones should go through a more detailed evaluation. If it is decided that a building will probably face total collapse when earthquake occurs, it should be made compulsory for the owners to strengthen this building at least up to the collapse prevention level. The government can provide low interest loans to building owners for retrofitting purposes or there can be significant tax reductions for retrofitted buildings.

The proposals for the seismic rehabilitation specific to Turkey on the micro level are explained below. A more detailed covering of this subject and a proposed model can be found in a previous paper of the author [15]:

- Before retrofitting the buildings, other seismic hazards at the building site should also be inspected as site-specific hazards can give substantial earthquake damage to a building although the building can be an earthquake resistant one. The site-specific hazards can be fault rupture, liquefaction, landslides or tsunamis. It may be more cost-effective to mitigate the site hazards instead of retrofitting the building.
- Any chosen rehabilitation strategy must ensure that there is enough redundancy in the system. This will prevent the local collapse that could occur due to the failure of some components.
- In Turkey, the ground floors of the buildings are usually used as stores, whereas the upper stories are used for residential purposes. Thus the infill walls are removed in the ground floors for enlarging the floor areas. If the capacity of these existing buildings are not found to be adequate, one way of retrofitting the columns of these ground floors should be jacketing. Jacketing is one of the compatible methods for retrofitting the existing building stock in Turkey. Its advantages are:

- Jacketing is cost-effective,
- The engineers and workers in construction industry in Turkey are familiar with this method,
- Stiffness of columns can be increased by jacketing them,
- Buckled, fractured or corroded bars can easily be replaced by new reinforcement in the jacket,
- The crushed concrete can easily be changed at the time of jacketing and with less effort,
- The deformation capacity can also be improved and shear strength increased by adding stirrups in jackets,
- Weak column strong beam frames, which are frequently observed in Turkey, can easily be transformed to strong column weak beam frames by jacketing the columns.

- One other common problem in Turkey is the corrosion of reinforcement especially in the basement and ground floors. If the corrosion damage does not continue above the basement floor, the columns

of the basement floor can be jacketed or additional peripheral shear walls can be added to the basement floor. Addition of shear walls is the other most compatible method with the building stock in Turkey. The method has many advantages such as,

- Increased lateral strength, stiffness, and energy dissipation.
- Cost-effectiveness,
- Familiarity with this method in Turkish Construction Industry,
- Very useful in controlling the global lateral drift : the effect of the shear walls is to shift the performance point for the structure to a lower spectral displacement,

- One of the other most common problems in the Turkish existing building stock is the existence of adjacent buildings which are vulnerable to structural damage from the 'hammer effect' that results when the two buildings collide. The gap between these buildings is commonly insufficient. The only way to mitigate these buildings will be to increase the stiffness of both buildings so that the seismic deformations are reduced.

CONCLUSIONS

The current problems related to the earthquake risk reduction in Turkey are discussed in detail in this paper. The main emphasis was on the legislative, economic and technical aspects of mitigation. The current handicaps to effective mitigation in Turkish legislation are discussed and strategies to improve the current legislative structure of Turkey are proposed. The current problems of Turkish building stock are discussed and strategies to rehabilitate the current building stock in Turkey are given. Economic alternatives such as cat bonds for hedging the catastrophe risk in Turkey are described. It is apparent that the situation in Turkey after catastrophic earthquakes is a mirror of the political and economic situation in the country. Policy failures in the successful management of the country and policy failures in managing earthquakes take their root from the same causes.

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