Indian Association of Structural Engineers

PANEL DISCUSSION ON

Turkey Earthquake - Lessons for India

Tuesday, 07 March 2023, 04:00 PM to 06:00 PM (IST)

ABOUT THE PANEL DISCUSSION

Recent major earthquake and subsequent aftershocks have devastated Turkey with more than 45,000 casualties and innumerable property losses. Recorded ground accelerations are as high as 1.8 g and for a wide range of natural periods, acceleration values are more than 1g. Losses are attributed to mainly two reasons viz., a) unusually high acceleration and b) poor quality of construction. While 60 per cent of India is prone to moderate-to-severe earthquake events, most of the built environment is not code compliant. In this regard, there is an urgent need to understand the consequences if a similar earthquake occurs nearby a densely populated area in India. What would be the scenario and how the country would face the situation? To discuss the same, IAStructE is proposing a panel discussion on "Turkey Earthquake - Lessons for India" on 7th March 2023.

SPEAKER

Dr. Alp Caner
Professor, METU, Turkey

PANELISTS

Mr. Kamal Kishore
Member Secretary, NDMA

Prof. Mahesh Tandon
Past President & GC member, IAStructE

Prof. CVR Murthy
Professor, IIT Madras

Ms. Sangeeta Wij
GC member, IAStructE

Prof. Raghukanth
Professor, IIT Madras

MODERATOR

Mr. Manoj Mittal
President, IAStructE

Mr. Alok Bhowmick
Immediate Past President, IAStructE

Dr. R. Pradeep Kumar
Vice-President, IAStructE (South)

https://theseismicacademy.com/event-detail/turkey-earthquake---lessons-for-india

AN INITIATIVE TO DELVE INTO PREPAREDNESS & MITIGATION BY IASTRUCTE

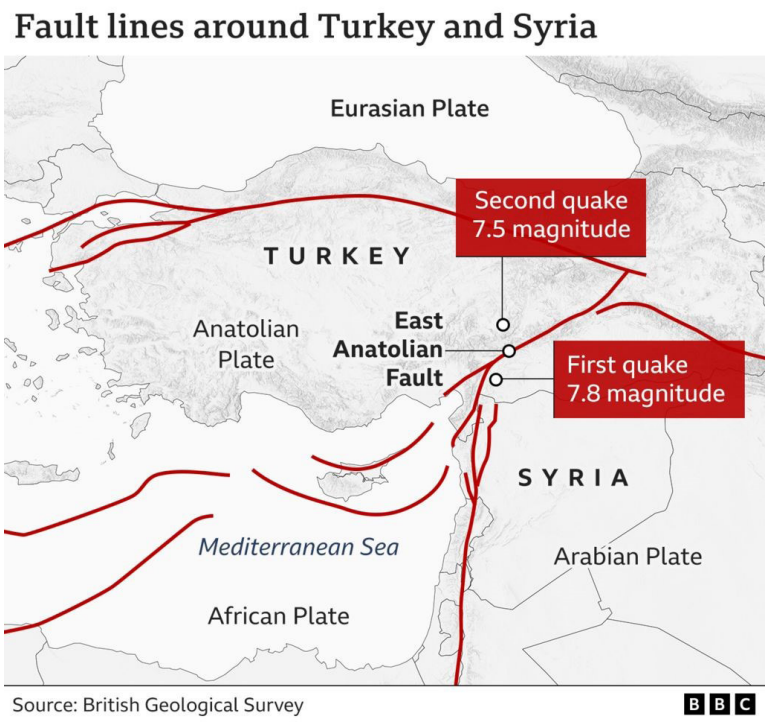
Nature's Fury Devastates Lives of Thousands

A 7.8 Richter Scale Magnitude Earthquake jolted Central and Southern Turkey and Western Syria on 6th February'23 in the local early hours laying a trail of catastrophe to be hit again by an unusual and powerful main shock of 7.5 Magnitude. A unanimous take on this is still awaited in the global platform to understand the second ones nature – was it an aftershock or was it another major earthquake triggered by the first one. The first quake occurred 11 miles below the surface, 34 km West of Gaziantep city, Turkey causing structural damage as far away as Israel and Cyprus. The second temblor occurred 60 miles North, 9 hours after the first one.

Leaving destruction, death and despair – the Turkiye-Syria Earthquake – has been one of the deadliest and strongest earthquakes to hit Turkey in modern times. The relative motions of three major tectonic plates (Arabian, Eurasian, and African) and one smaller tectonic block (Anatolian) are responsible for the seismicity in Turkey.

As per reports, there were atleast 48,448 deaths and 115,000 injured across the 11 provinces of Turkey and an approximate 13.5 million people and 4 million buildings affected. The disaster led to the damage of around 345,000 apartments with many up for demolishing owing to the risk factors. By 23 Feb. '23, the Ministry of Environment, Urbanization and Climate Change conducted damage inspections for 1.25 million buildings; revealing 164,000 buildings were either destroyed or severely damaged. A further 150,000 commercial infrastructure were at least moderately damaged. The International Organization for Migration estimated about 2.7 million people were made homeless.

Since the epicenter was very shallow, the intensity of the ground shaking made the earthquake more damaging. The large number of very strong aftershocks also destroyed buildings already weakened by the first event. The region is also prone to the risk of seismic liquefaction and landslides.



With such a large number of infrastructure and building collapse, resulting in loss of masses, the Turkey-Syria Earthquake has raised questions in the minds of people – Building Safety: Codes and Adherence. Modern construction techniques should mean buildings can withstand quakes of this magnitude. And regulations following previous disasters in the country were supposed to ensure these protections were built in.

Failure to Enforce Building Regulations

Construction regulations have been tightened following previous disasters, including a 1999 earthquake around the city of Izmit, in the north-west of the country, in which 17,000 people died. But the laws, including the latest standards set in 2018, have been poorly enforced where over half of all buildings were put up illegally.

Construction safety requirements vary depending on a building's use and its proximity to areas most at risk of earthquakes: from simple strengthening, to motion dampers throughout the building, to placing the entire structure on top of a giant shock absorber to isolate it from the movement of the ground.

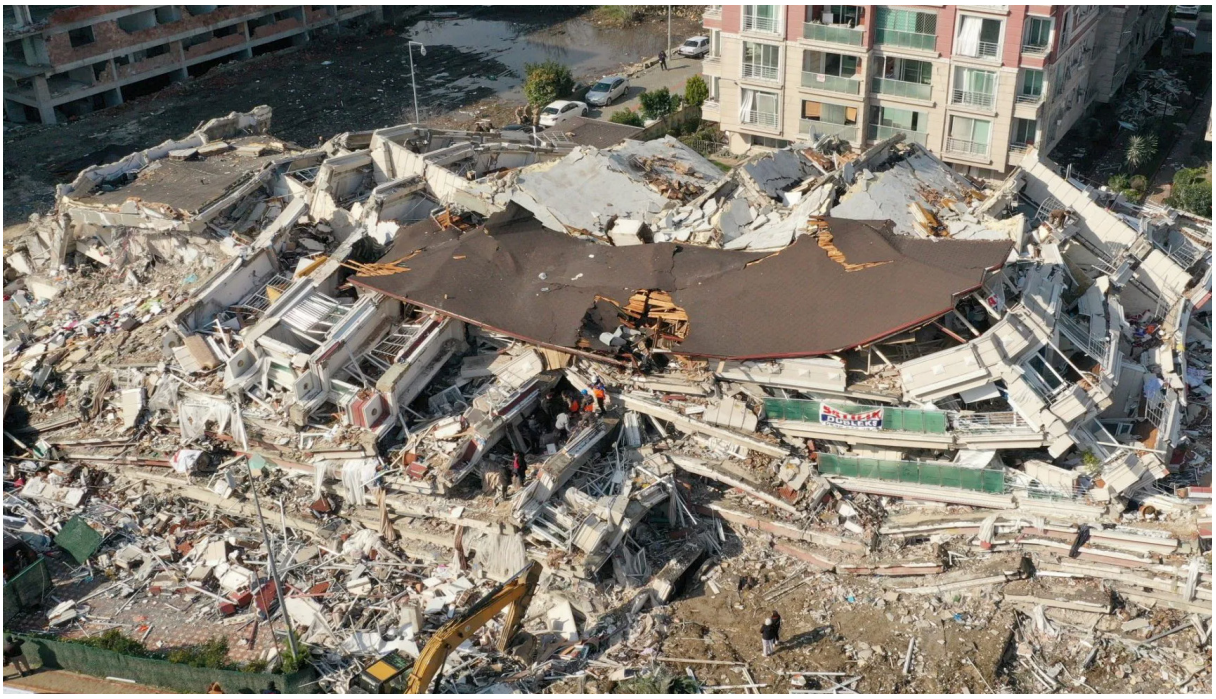
Lessons for India

To create more awareness on the topic by learning from the disaster in Turkey and to highlight on the seismic design requirement in India to build a safe built environment, a panel discussion was organized by Indian Association of Structural Engineers (IAStructE) on 7th Mar. '23. The panel has the lights of Dr. Alp Caner, Professor, METU, Turkey; Prof. Mahesh Tandon, Past President & GC Member, IASrtuctE; Prof. CVR Murthy, IIT Madras; Ms. Sangeeta Wij, GC Member, IAStructE; Prof. Raghukanth, IIT Madras; Mr. Manoj Mittal, President, IAStructE; Mr. Alok Bhowmick, Immediate Past President, IAStructE and Dr. R. Pradeep Kumar, Vice-President, IAStructE – South.

Few points which were captured during the session are as follows:

Sh. Manoj Mittal, President, IAStructE commenced the webinar with his presidential address. He stressed on the importance of Building Codes and specially, on adherence/compliance to such codes to enable maximum possible mitigation in such seismic catastrophes. He enumerated various earthquakes that have hit India and how one of them, Bhuj Earthquake, became the tuning point for the industry which led to renewed & improvised codal system in the country. He raised a few thought provoking questions as to even after strict revision, thorough checks being made mandatory, incorporating disaster management infra; is India really safe? Are we prepared to handle such a devastating earthquake as Turkey faced? Is the Indian infrastructure, earthquake resistant and code compliant and several others. He emphasised on the crucial role played by the civil engineers to deal with such situations where it is required to handle comprehensively. He pointed out some major challenges such as: quality standards of engineering graduates; effective regulatory mechanism of engineering profession; competence based registration and licensing of engineers; capacity building; development of code and commentaries; promoting and ensuring ethical practice by engineers; identifying high risk structures and undertaking audit, retrofiring of such structures; increasing earthquake literacy of architects and general public. It is required to work on these aspects with greater commitment and mission mode manner.

Prof. Dr. Alp started with a background of movement of tectonic plates which led to the occurrence of the Turkey earthquake. He mentioned that India also has an active fault line and this can be of problem in future if proper mitigation measures are not adopted during design and construction. A storm of earthquakes were observed in and around Turkey in a region 700 km in length and 200 km in width in the last 30 days. After the earthquakes, 11 cities have been reduced to emergency states.



His key observations were soil related problems caused considerable damage on many structures and also the earthquake design response spectra curves had underestimated the earthquake storm. New buildings which were designed considering non-linear analysis were found to undergo severe damage and in some cases collapse. He touch based upon the seismic performance levels of structures as per the seismic design standard in Turkey (namely, immediate occupancy, minimum damage, repairable damage, life safety). He identified few reasons for buildings suffering extensive damage like lack of shear walls, vertical or plan irregularities, construction on slope, soil conditions, poor construction practices (e.g., use of rounded aggregates from rivers, improper reinforcement details, etc.) and near fault location. Structures like bridges and tunnels, which were in the near fault locations and/or constructed on poor soil, were found to undergo significant damage.

Prof. Alp also added that structures with flat slabs do not perform well in earthquakes and the same was observed in Turkey earthquake as well. Most of the structures with provision of shear walls to render stiffness were not observed to collapse and the ones which failed were primarily due to the extensive soil displacement. He mentioned that the current standard in Turkey highlights requirement

A sequence of images shows workers demolishing a quake-damaged building in Malatya, Turkey, on March 7, 2023. More than a thousand damaged buildings in the region have been demolished since the February 6 earthquake

of shear walls in building structures but does not spell out very explicitly on the extent of provision. Hence, the same is sometimes left to engineering judgments. He also added that in business units in the ground floors, it often happens that the owner explores non-engineered solutions (to the extent of removing columns in the ground floor) which are extremely detrimental to the structural stability. In certain cases, the failure is attributed to use of poor building materials. Also, poor construction practice was another probable reason for failure, since ductility requirements are very detailed and labour intensive; these are sometimes not precisely followed and the desired performance might not be achieved. Prof. Alp added that base isolated structures survived the earthquake and were immediately occupied.

Prof. Raghukant in his deliberation on the Turkey earthquake and reference to the Indian scenario, mentioned that looking at the strong motion data and report of the Turkey earthquake, it is evident that earthquakes are capable of producing PGA of more than 1g in the near field region and earlier earthquakes like the Assam earthquake, Gujarat earthquake have experienced very high PGA in the near field region. His recommendation was to design the important structures to withstand this kind of high ground motion. He also mentioned that it would be interesting to study the complex fault geometry

and understand how these are translated to ground motion values. His recommendation also was to derive near field correction factors based on the spectra.

Prof Mahesh Tandon, in his presentation on the geotechnical aspect referred to the preliminary report published by METU and enumerated that there is evidence of loss of strength of soil, occurrence of liquefaction in the soil at many places and high settlement (up to 80 cm) of few buildings. Buildings appeared to be affected the most with slope failure observed in many cases, while tunnels deep excavated walls, mechanically stabilized walls continued to perform without much signs of distress. He mentioned that the zone factors suggested in IS 1893 part 1 are at the base rock level and in far-field conditions. His recommendation to the standardization body for the development of next revision of earthquake design standard is to include a suitable amplification factor (in line with FEMA -P 750) for PGA values for ground motion due to overlying site soils. Prof. Mahesh Tandon added that it is always recommended to refer to specialized agency to develop site specific spectra and the same should be considered in design. If the recommendation of the site specific spectra is lower than the code, the codal provision has to be followed. Non-compliance to the same can eventually lead to disaster.

Prof. CVR Murty in his observation, mentioned that near fault effects were predominantly observed in Turkey and asked whether any action would be proposed to account for near fault effects in the future standards in Turkey. About 4000 km of the landmass in India is also having near fault effects and would also require to be prepared for the same. He also requested to share more insight on the performance of non-linear analysis based buildings during the earthquake. He emphasized that lack of structural walls in buildings was one of the major reasons for their poor performance during the quake and took reference of the Mexico earthquake where use of flat slabs, absence of structural walls caused extensive failure in structures.

He insisted that in high seismic regions, flat slabs are not encouraged and are not the greatest of structural systems - in the inelastic zone, the flat slabs due to their limited geometry would crack and the columns are rendered cantilever behavior, which is not considered in design philosophy. In case of accommodating adequate parking space in the ground storey of a building, Prof. Murty mentioned that it is required to provide adequate structural walls or structural bracings to ensure that the building does not become weak due to provision of open (ground) storey. In absence of comprehensive course content on non-linear analysis in college, his recommendation was to adopt the good part of configuration, stiffness, strength, ductility requirement of linear analysis in design process. To address the concern regarding feasibility of performance based design (PBD) for composite structures, Prof. Murty mentioned that PBD is a process to understand the behavior of the structure and is independent of the type of material being used. The challenge with dissimilar materials will be due to the fact that they have different strength, stiffness, deformability, ductility and this will call for comprehensive experimental data to support the particular combination, generation of realistic backbone curve and cyclic hysteresis rules for such situations. He also added that plane (unreinforced) masonry structures are less to survive in high seismic regions. In such cases, the preferred approach is to either adopt confined masonry or reinforced masonry and the same will be captured in upcoming revision of earthquake standards in India.

Er. Sangeeta Wij mentioned that lack of code compliance has come out as the main reason for mass destruction in Turkey & Syria. She recommended that in the current Indian scenario, there is an urgent need to review all existing buildings for their performance levels. She made reference to the National

Building Code 2016 which has clearly spelled out the requirement in this regard. She expressed her serious concern about the growing number of non-compliant buildings in the country. She pointed out that, structures with large cantilevers, irregular geometry, soft storeys, mass irregularities, flat slabs, floating columns, etc. as some of the major reasons which may lead to extensive distress in the event of earthquake. She highlighted that during the Covid-19 pandemic, many hospitals were built to address the increasing demand for healthcare facilities. However, many of them did not have adequate stiffness in the form of shear walls. Hospital, schools and all public buildings should be audited and retrofitted to avoid any chaos post disaster and also help in mainstreaming the relief activities. She took reference to NDMA Guidelines for Hospital Safety in this regard and encouraged implementation of the guidelines for new and as well as for existing healthcare facilities. She also shared that the awareness and implementation of the tall building standard (IS 16700-2017) among practicing engineers has not been very encouraging. She also encouraged the adoption of IS 13920 for ductile detailing by practicing engineers.
Ultimately, building codes are the minimum design and construction requirements to ensure safe and resilient structures. These codes reduce casualties, costs and damage by creating stronger buildings designed to withstand disasters. The purpose is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures.

In Sh. Alok Bhowmick's concluding remarks, he conveyed his condolences to the people of Turkey and India's solidarity in such a despairing situation. He proceeded to summarise the webinar by thanking the esteemed speaker and panellists. He pointed out the PM's 10 Point Agenda on Disaster Rate Risk Reduction on NDMA's website from where he selected one to highlight: Make use of every opportunity to learn from disasters and to achieve that there must be studies on the lessons after every disaster.

He proceeded on to highlight the Preliminary Recognition Report available on the public domain where the first lesson learned is the use of digital technology in data collection from the disaster which was carried out in Turkey within just 15 days. The second learning is the Emergency Response System which did not perform satisfactorily in Turkey earthquake. Are we prepared to cater to such situations? The third lesson was the Ground Motion Data which has indicated that the earthquake demands were much higher than expected in the median period range where PP ground accelerations as well as PGB was much higher along with the vertical seismic even if it was a strike slip kind of a fault zone. He emphasised on some needs other than the codes such as upgrading the quality of construction; making sure that there are some techno-legal regime in the country that is licensing and enforcement; making sure that the codes are understood by the most of the people who are actually designers and is implemented as per code.

To view, click - https://cdnapisec.kaltura.com/html5/html5lib/v2.96.2/mwEmbedFrame.php/p/1858191/uiconf_id/29529811/entry_id/1_h2us49ou?wid=_1858191&iframeembed=true&playerId=obj_KalturaPlayer&entry_id=1_h2us49ou