New Emergency Management in a Resilience Era Facing Health, Climate and Energy Challenges

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Need of sustainable approach to infrastructures in resilience era

- Sendai, Japan, UN World conference 2015 adopted resolutions fixing goals, targets, purposes and priorities towards disaster risk reductions and sustainable resilient safe world.
- Earthquakes, tsunami, floods, cyclones and other natural disasters are unpredictable.
- Seismically deficient buildings including old and industrial structures, earthen / concrete/ gravity dams, roads/ highways/ railways / underground transportation system, bridges, tunnels and other infrastructures are very vulnerable to earthquakes.
- Global warming, melting of glaciers , wildfires , tsunami/ floods ,cloud bursting ,raising sea level etc are caused due to Climate changes and energy changes.
- Development of Safe infrastructures will enable the world to sustainable resilience.
- It is of prime importance to see that all new structures , urban renewals are constructed as per codes and standards of the country as multi hazards resistant structures to the extent possible which will enable the world in mitigating future disasters and face the challenges created by climate changes and energy changes.
- UNO, WHO, World Bank and other world bodies have to play major roles . Success of Paris agreement is essential to achieve sustainable resilient safe world.

Earthquakes resistant and Sustainable resilient buildings

- Earth quake resistant new buildings in India are constructed in compliance of IS 1893 code first published in 1962, revised in 1966, 1970,1975, 1984, 2002 and 6th revision in 2016 - IS 1893 (part 1) , incorporating lessons learnt from past earthquakes and modifications made in international codes time to time.
- Structures designed as per IS 1893 (Part 1 to 5) and IS 13920: 2016 are expected to undergo minor structural damage but not expected to collapse during strong earthquake ground shaking.
- Failures of non-structural elements like *towers, tanks, parapets, smoke stacks/ chimneys brackets, cornices and balconies etc* and their attachments cause huge damages. In India these are designed as per IS 1893 (part 1).
- Industrial buildings are also vulnerable to earthquakes and the associated accidents. IS 1893 (part IV) has stipulated criteria for earth quake resistant design of these buildings in four categories depending on their vulnerabilities.
- Use of Base Isolators and energy absorbing devices are being promoted in seismic zone III, IV and V in India.

Earthquake resistant and Sustainable Urban renewals

- About 60 % of total area of India is seismically vulnerable
- For sustainable development , old existing buildings need to be surveyed for assessment of their fitness in respect of earthquake resistance ability.
- Retrofitting of those seismically-deficient buildings which require strengthening due to (i) building was not designed as code, (2) subsequently updating of the codes and design practice, (3) modification of the building (4) deterioration of strength due to ageing of the buildings(5) damaged after earthquake etc are needed to be identified.
- Urban renewal/ retrofitting schemes should be prepared accordingly.
- Urban renewal schemes should be prepared considering the latest population data and rainfall data, storm drainage system, provisions of sewage treatment plants , essential component of smart city concept, elements of green building concept, rain water harvesting, water conservation, eco- friendly environment including forestation etc as per guide lines covered under Energy conservation building code and or National Building code of India2005/ 2016.

Multi hazards resistant designs

- Along with the shaking of ground during earthquake causing serious damages, other chain of effects like landslides, flood, tsunami, fires, cracking/ sinking of ground, artisan action, bursting of underwater stream etc, unpredicted level of destructions can happen and have been experienced in some of the past earthquakes in different parts of world.
- It is important to take necessary precautions in site selections, planning and design of structures, so that they are safe against such secondary/ multi hazards effects also.
- Many districts are identified as multi hazards prone as per National Buildings Code of India .
- Prevailing codes covers criteria for design against single disaster. Therefore ,it is necessary to stipulate required guide lines against multi hazards for developing different types of structures. In absence of the same it becomes equally necessary for the planners and the designers to cross check the safety of the designed structures against the pertaining codes of related multi hazards individually and the structures should have required capacity to with stand the worst situation.
- Existing buildings including new buildings should be suitably strengthened against floods and lateral forces in coastal areas.
- Fire safety standards for all structures as per N.B. code-2016 are to be followed in India

Seismic designs of earthen, concrete/gravity dams and embankment

- In event of earthquakes earthen dams and embankments have suffered extensive damages causing loss of life and properties.
- This is expected to be further devastating in view of unpredictable excess rainfall in the catchment, cloud bursting and flash floods etc.
- Earthquakes likely to cause Slope failures/ Liquefaction/Fault displacement under foundations, Crest settlement , Permanent deformation of foundation soil/dam body, Shear Sliding of dam slope, Piping and Erosion etc.
- Defensive design measures like (i)additional dam height for loss of crest, (ii) features of crest to reduce the chances of overtopping (iii) wider transition and filter sections against cracking (iv) Zoning of embankment to minimize saturation of materials (v) ground improvement to mitigate liquefaction (v)installation of suitable instrumentations to minimize piping through seepage cracks , are to be taken.
- In event of earthquake concrete/ gravity dams and embankments are very vulnerable. These structures require more stringent design criteria regarding free board, seismic slope stability and dynamic/ hydrodynamics analysis etc

Seismic vulnerability of road network, bridges and tunnels

- Destructive seismic effects are caused by violent shaking of ground and fault rupture etc, resulting in ground displacement, cracking, landslides, rock falls, failures of steel bridges/ other bridges etc creating road closures and stopping transportation.
- Substandard and deficient bridges are vulnerable to strong ground motions caused by earthquakes. Situation becomes severe if bridges suffer structural failures and or foundation failures.
- IS 1893 (part 3) and IRC- 6 codes cover provisions for design of new bridges, seismic evaluation of existing bridges for their seismic up-gradation and retrofitting of bridges.
- It has to be ensured that requirement of "Serviceability limit" as per limit state design under DBE level and "ultimate limit state" design under MCE level has been checked.
- Tunnels have been part of major infrastructures for development of transportation network .
- Deeper tunnels or rock tunnels are estimated to be safer in general including seismic effects.
- Some of seismic damages/ failures include (i) Cracking in tunnels linings (ii) Landslide induced failures (iii) Uplift of bottom pavement (iv) Failure of side walls (v) Lining collapse caused by slope failure . Protection measures include monitoring of tunnel safety effecting factors.

Floods and related disasters and Cloudburst

- Floods are major disasters in the world and are caused by heavy rainfall, rising of river bed, meandering of river including changing of its course, rapid snow melt, a storm surge from a tropical cyclone or tsunami in coastal areas and cloud bursts etc .
- Human factors such as blocking drainages channels, improper land use, deforestations, failures of dam, heavy release of water flooding down-stream areas etc.
- Integrated flood management has to be developed, incorporating city development plan, urban drainage, control of flooding water source, construction of embankment, flood walls, ring bunds, flood control reservoirs, river training works, de-silting of river bed, improving surface drainages, activating of abandoned old river courses, interlinking of rivers etc .
- In India many river basin suffer serious disaster due to spreading of flood water. Re-planning of habitation on high levels and water sheds in low areas with safe communication in such areas of basins could mitigate the disaster.
- Mountain cloudburst cause sudden and destructive flash floods flowing with enormous amount of kinetic energy. Precautions are: flood warning , buildings above H.F.L, creation of water storage areas, less constructions on river bank and modification in houses to be safe.

Climate and energy changes, Paris agreement, 26th COP

- Paris agreement is a landmark legally binding International Treaty on climate change adopted at COP 21 in Paris with goal to limit global warming to well below 2°C and pursuing efforts to limit to 1.5°C this century. To achieve this temperature goal, countries to reach global reduction of greenhouse gas emission (GHGs) and to pursue actions needed for low carbon future. For resilient development of the safe world, achievement of goals of Paris agreement will act as pillars in future.
- 26th Conference of parties (COP) held at Glasgow (UK) on climate change has proposals like to secure net-zero emission by mid century, 2030 emission reduction targets, phasing out coal, Curtail deforestation, switch to electric mode of transportation, generation of solar and other renewable energy etc.
- In 26th COP, India has given commitments (i) **net-zero emissions by 2070 (ii) non-fossil energy capacity to 500 GW by 2030 (iii) carbon intensity down to 45 % by 2030 (iv) 50 %** of its **energy demand through renewable energy by 2030 (v) reduce 1 billion tonnes of carbon emissions by 2030** (vi) **Indian Railways' target of net zero emissions by 2030 (vii) reducing 40 billion tonnes of emissions through the use of LEDs**.

Vetting of analysis , design and drawings and Conclusions

- For sustainable resilient infrastructures, they all have to be safe against different hazards .
- Earthquake and other multi hazard resistant structures involve specialized design expertise . It has been experienced that considerable improvements are needed in the original analysis, designs and drawings after appraisal..
- Structural designs for structures on poor soil, or in hilly areas, or on active fault trace in seismic zone III, IV and V, to be carried out by a structural engineer on record (SER) or structural design agency on record (SDAR). Proof checking of various structural designs has to be carried out by the competent authority / structural design review panel (SDRP) .
- **Conclusions**: (i)It is recommended that for tackling hazards related to these infrastructures, detailed standard operating procedures with full clarity be formulated by expert panels.
- Use of latest scientific mitigation tools and systems including research should be promoted.
- . The world have to be positive to face challenges created by climate change and achieving the targets/ goals laid down in Paris Agreement .
- Provisions of Energy conservation building code be adopted for sustainable infrastructures.
- Use of new and innovative materials, equipments and technologies be adopted for sound quality of construction for resilient infrastuctures.

References

(i) IS 1893 (2002/ 2016: Criteria for *Earthquake Resistant Design of Structures*
Part I- general provisions and buildings
Part 2- Liquid retaining tanks
Part 3- Bridges and retaining walls
Part 4 – Industrial structures, including stack-like structures
Part 5- Dams and embankments

(ii)) IS 4326-1993 *Earthquake Resistant Design and Construction of Buildings*- Code of Practice

(iiii) IS 13920-1993/ 2016 : *Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces*- Code of Practice

(iv) Murthy, C.V.R., *Earthquake Tips (1-25),* Journal of Structural Engineering

(v) Agarwal, Pankaj, and Shrikhande, Manish, *Earthquake Resistant Design of Structures*, Prentice - Hall of India Private Limited, New Delhi.

(vi) Hand book on seismic retrofit of buildings – CPWD/ IBC/ IIT Madras

(vii) Guide lines for improving wind/ cyclone resistance of housing published by BMPTC, 2010

(viii) IITK-GSDMA Guidelines for seismic evaluation and strengthening of buildings (2005)

(ix) Seismic evaluation and strengthening of existing reinforced concrete buildings—guidelines.

(x) National Building Code of India 2005 and 2016, (xi) IRC 6-2014