Quiz 2

Lecture 09 : 4th Feb '21

CYCLONE

→ Storm vs Flood

→ Cyclone – mushroom / conical shape

Name – depends on area

Atlantic / Eastern Pacific – Hurricane
Western Pacific – Typhoons
Indian Ocean – Cyclone.

No cyclone near equator as storms tend to curve to the north & east as they interact with the westerlies. — due to lack of coriolis effect (coriolis force is almost zero)

↓

In N° Hemisphere – wind turn right
S " – " " left

Cyclone Types

① Tropical Cyclone

- warm core (than surrounding air)
- low pressure system without any 'front'
- long tails
- develops over tropical / subtropical waters
- has an organised circulation with winds of at least 120 km/h
- strongest winds near the earth's surface
- energy source : energy fluxes from warm ocean

② Extratropical cyclone
- cool core (than surrounding air)
- Strongest winds near upper atm
- 700-1000 mile dia
- Has fronts (strong fronts)

- forms outside the tropics
- energy source: Horizontal Temperature Contrast

Formation

① a. Ocean water above 80°F (for evaporation)
b. warm water must be about 200 ft. deep because storm stirs up the ocean bringing cold water from below.

② Winds need to be coming together converging near surface

③ Air needs to be unstable so it will continue rising
(when difference in temp. is negligible, its cl. stable air)

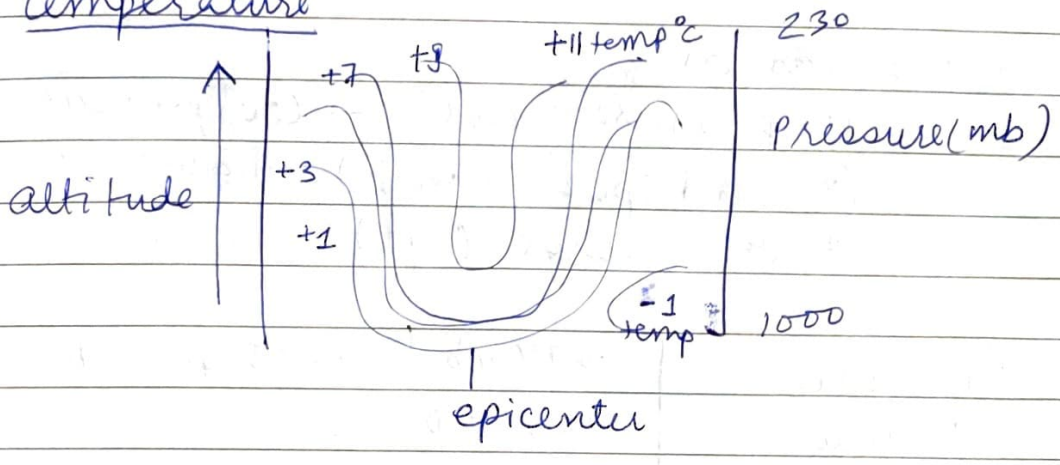
④ Air upto about 18,000 feet needs to be humid as it is pulled into the storm. This extra water vapour supplies more latent heat energy.

⑤ Pre-existing winds (not created by storm) should be coming from nearly same direction (and close to same speed) at all altitudes to avoid ripping the storm apart.

(6) An upper atm high pressure area helps pump away ~~anything in t~~ air rising in the storm.

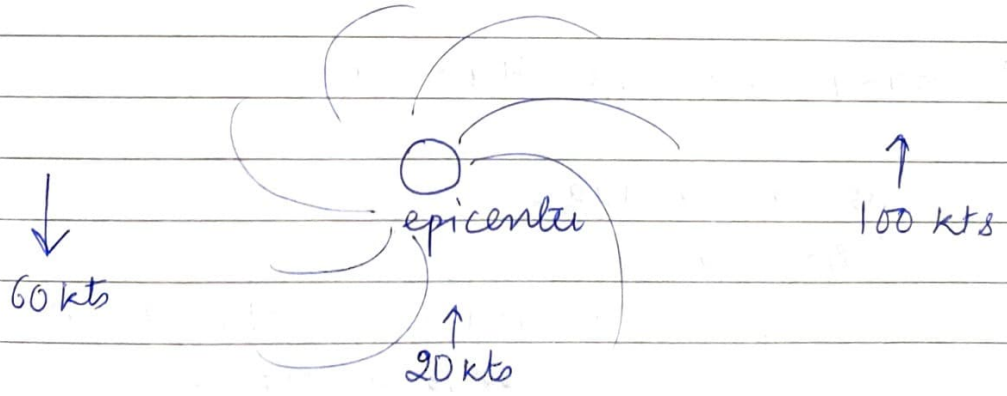
→ Spiral rain bands — at the peripheral (kilometers away from eye of cyclone) That's why heavy rainfall away from the eye.

→ Temperature



→ Winds

1 kts = 1.85 kilo/hr.



when hurricane passes a region =

① high winds due to periphery
② ~~every~~ eye of hurricane
③ other end (periphery) — storms

Hurricane Decay

- weaken during landfall / go over cool water
  - landfall → when it hits the land

Hurricane Intensity Scale

→ Saffir - simpson hurricane damage potential scale

→ depends on

1. pressure (inch) — less pressure — more intense
2. wind speeds (mph) — high speed — "
3. storm surge (ft) — more — "

Minimal	>980 mb	74-95 mph	4-5 ss
Moderate	965-980	96-110	6-8
Extensive	945-964	111-130	9-12
Extreme	920-944	131-155	13-18
Catastrophic	<920	>155	>18

(universal)

Primary Hurricane Hazards

- wind damage
- Flooding
  - Heavy rain for inland (Bands)
  - Storm surge along shoreline

Losses

- deaths ↓ (have come down) but the cost of hurrican damage has ↑sed

because most structures are built using

costliest NSE

Cyclones in India

- 6 zones
- Hazard more along east coast than west coast.

~6 cyclones per year.

Indian Meteorological Department

Category	Wind speed (knots)
Low	<17
Depression	17-27
Deep Dep.	
Cyclone	34-47
⋮	
Super Cyc	≥120

No. of cyclones

Orissa > Andhra > WB > TAmil N.

How does IMD issue warnings

Several stages in cyclone warning: (SLIDES)

1. Precyclone watch (SLIDES)
2. Cyclone Alert
3. Cyclone warning
   - at least 24 hrs in advance to better manage death & fatalities as ppl can be evacuated from regions.

④ Post-landfall outlook
└ DM more localised when it comes to landfall

⑤ De-Warning Message
After the storm passes & as soon as it hits the land or landfall occurs — it weakens considerably — bringing more rain, wind — it weakens & stops

→ Warnings issued to many communities (SLIDES).

→ EWS (slides)

~~it became stronger & stronger even when it approached the land.~~

Odisha 1999
└ super cyclone to hit India
└ govt. learnt a lot

After the cyclone,

the govt, SDMA did a lot of efficient groundwork & homework and —
① installed Modern comm. sys
② constructed cyclone shelters
③ " improved infrastructure
④ constructed pucca houses for poor in cyclone-prone areas.
← non engineered but strong

⑤ Increased the capacity of CBDM

by launching CBDPreparedness program in 2001-2002 & Disaster Risk Management (DRM) programme (2002-2009)
This was a combined program b/w UNDP & GoI.

(6) GoI-UNDP DRR programme (2009-12)
- strengthened institutional arrangements to undertake the following activities:
  a. DRR activites at various levels to develop preparedness for recovery. — like DRR in some regions (seides) & URR in some

(7) Invested in resilient infrastructure such as emergency shelters (not temporary ones)

(8) Trained CBO for cyclone shelter management, maintenance committees & shelter level task force members. (managing evacuated ppl in shelters)

(9) Strengthened State and district Emergency Operation Centers

(10) Supplied critical equipment to ODRAF, fire stations & emergency shelters.

Phailin (2013) October

- became stronger and stronger as it approached the land
- it went much ahead into the land as compared to what was forecasted.

- sustained max wind speed of 200-210 km/hr
- very heavy rainfall - floods & strong gale winds caused large scale structural damage & storm surges triggered coastal ~~of~~ inundation
  - ~~above~~ 3-5 meters above the astronomical tide

LOSSES (Slides → numbers)

- Houses
- Transmission towers

PREPAREDNESS

(1) → GoOrissa was well-prepared & proactive

(2) → ~~used~~ SDMA used the updates from IMD to track the cyclone every minute
- the path, intensity & magnitude of cyclone

(3) → Launched a range of preparatory activities
→ Had a zero casualty approach

(4) OSDMA
- Conducted mock drills at all cyclone shelters

(5) Actively checked & replaced availability of equipments at shelters because shelters will/may also face damages

(6) Activated shelter management / maintenance committees

(7) Provided satellite phones for communication to all 14 cyclone prone districts

(8) ~~ensured~~ 4000 free kitchen centers were opened where 2 million affected people were hit.

(9) 338 medical relief centers were opened having 185 medical teams

(10) Engaged nodal NGOs

(11) Largest emergency Evacuation
- people living in low-lying areas and kutcha houses / tin roof houses within 0-10 km of coastline evacuated to nearby cyclone shelters or other identified safe buildings.
- livestock was moved to safer places

↳ 1 million people evacuated within 36 hrs. preceeding landfall

(12) Close collaboration b/w ODRAF (Disaster Rapid Action Force), NDRF, CRPF, OSAP, IAF etc.

RECOVERY (Slides)

- Roads restoration in 24 hours
- 5-7 metric ton of dry food air dropped to inaccessible areas.

- Reconstruction needs

MORE TO GO (Slides)

→ create Corpus fund for maintenance of shelters

- Planned Infrastructure
  - Waste disposal site – debris created needs to be identified & disposed of

- Strengthen Integrated Disaster Resource Network. (IDRN)
  - all data & resources for DM in the country

Cyclone Resistant buildings Architecture

① Shape

Square ✓

Rect → ~~to~~ length ≤ 3 (width)

L-Shape

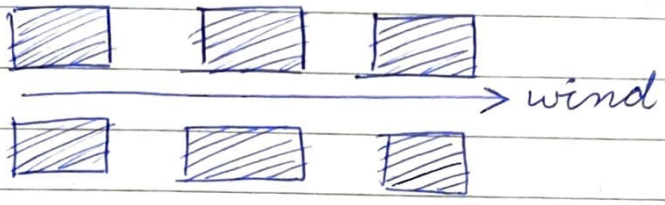
- chances of ~~co~~ concentration of wind in corner which can damage corners
  Hence, strengthen corners.

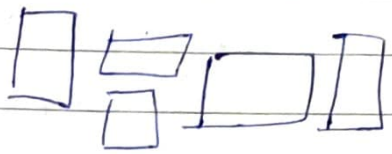
long rect X

X

② Orientation

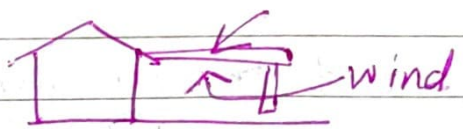
- Tunnel-like row creates winds however zig-zag planning avoids winds





③ Roof
- Anchored & secured roof
- Thatched tile roofs ⇒ to avoid flying off of tiles — roof has to be anchored & tied ≥ ropes in a graded manner.
- Secure roofs from inside as well so that the structure doesn't fall off.

④ Avoid
- long verandas & wide corridors



⑤ Foundation
- better to construct high foundations on braced stilts
- spread weight over wider area

⑥ Masonary Walls
- provide longitudinal reinforcements at sill (window) levels & lateral ties
- Vertical reinf. at corners

so that brick wall has more strength

⑦ Openings
- proper Anchoring for windows
- If glass windows — use adhesive tapes for glass protection so it doesn't break

(aluminium windows aren't anchored properly)

VISHAKHAPATNAM 2014 HUDHUD

Cyclones changed their direction few hrs before lanfall — so this created a belief that VS. is cyclone safe.

Hudhud
- Wind speed > 220 kmph
- strongest & most destructive cyclone to hit any Indian City
- caused heavy rainfall over N. AP and S. Odisha
- Storm surge of 1.4 meter above astronomical tide

LOSSES (slide)

Lessons Learnt (slides)

- Concept of crowd sourcing
  - most of the community participated (Participatory approach) in relief operations
- Because it was a belief that it will be diverted, evacuation of ppl was not complete before the cyclone
- Due to failure of communicat° network decision making became decentralised from EOC
- SE & NSE measures

classmate
Date
Page

Lecture 10 : 15th Feb '21

Earthquakes

- energy is released at a certain depth called focus
- exactly above it is epicenter
- distance measured from focus to building of interest is hypocentral distance.
- the release of energy causes fault rupture
- Epicentral distance - epicenter to building of interest

The energy released travels through the earth in form of waves

① body wave — through the soil which gets refracted/ reflected & reaches surface of earth

② Due to the intensity & magnitude of EQ, there will be surface waves as well.

Layers of Earth (slides)

→ Mantle is also in circulation as it is in a plastic, semi-solid state

→ Temp inside surface of earth is too high

and due to convection it reaches the surface of earth & into the magnetic field.

- when it reaches surface of earth, its temperature reduces & is always in motion

ONE THEORY → - Convective current/ movements in mantle wherein mantle rises and sinks when temperature changes ---- SLIDE

Pangea Supercontinent

↳ due to continental drift, the crust broke.

↳ main seismic plates

Another Theory : ELASTIC-REBOUD THEORY

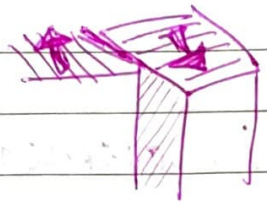
diff. type of motions keep happening @ in the earth. ~~So when the rock/soil reaches its capacity~~ and stress builds up in the crustal blocks causing deformation. when the blocks reach their capacity to hold this energy, it releases this energy causing rupture (earthquake)

- potential energy builds up in deformed rocks
- breaking of rocks causes fault & results in release of energy in form of an earthquake -

→ Earth rupture – the slips b/w crust.
Leg. Orange grove

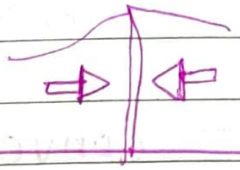
→ multiple fractures can occur
→ Two types of slips –

Horizontal



earth moves in horizontal

vertical



→ eg. San Andreas fault (longest fault).

→ Types of Inter ~~Star~~ Plate Boundaries due to motion of plates

Convergent = one plate goes in and other goes over it

~~Exam~~

eg. subduction zones

leads to creation of mountains

eg. Himalaya

Transform : slip against each other

Divergent = slip opposite each other

→ Types of Faulting

- Dip Slip : inclined fracture where blocks have moved vertically

- Strike Slip : longitudinal movement.

→ Reservoir Triggered EQ

eg. Koyna EQ in India
↳ water seeps in the earth through the fissures created in earth and build pressure inside the rock.

Ritches Magnitude

Seismograph – machine
Seismogram – plot

measure –

① max. amplitude
② diff in time durat^n b/w the p-wave & s-wave.

(P-S) × 8 will give the depth where fault has occurred.

8 km/s
speed of S-wave

③ 3 scales

distance (km) — mag — amp (mm)
Point 1 — Point 2

get mag by joining P1 & P2.

Magnitude ∝ 31 times energy

So, M1 = M8.4
M2 = M6.4

energy diff = $(31)^{\text{abs}(M1-M2)}$ ≃ 900 times more energy

→ acc-time graph is signature of EQ

diff EQ cause damage to diff types of buildings depending on the fundamental time period of these buildings

→ on soft (alluvial) soil, liquefaction happens where soil behaves like jelly
ie soil amplification

Characteristics:
→ Duration, Amplitude, frequency content
↓
that decide the intensity of EQ

EQ effects

① Vertical Elements
└ compression & tension

gravity — vertical load
EQ — lateral load
causes double curvature

② Wall

strong direct^n → EQ direct^n in the plane of wall
→ resisted well

weak direct^n
- ⊥ to plane of wall
- toppling

③ Box Action

Plinth : connect^n b/w walls & foundat^n
Lintel band : " " " & roof

Small openings
Stiff foundat^n

④ Floor Flexibility

① Out of plane
- imp for gravity loads
- vertical direct^n

② In plane
- for seismic loads

→ movement is resisted by centre of inertia

EQ DM

Imp { ① Mitigation = Risk Mitigat^{n} { good structure, trainin
② Preparedness

2011 Sikkim

└ Number - slides

→ ShakeMap (slide)
→ Past Events (slide)
→ Ground Motion
└ Peak Ground Acceleration

Landslides & Roads

→ Brittle slope failure - Nathula Pass
→ Road damage - steel carriage way
→ Building damaged by boulders
(Narrow spaces & insufficient equipment to clear landslides)
→ Mouth of Bridges were blocked due to landslides

(Slides) - Gabion walls
Random Rubble walls } to stabilize slope
↓
these were ⊕nt but still damage

Structures

→ Wood frame / stone walls — ~~out of plane~~ weak direction — wall fell down
↓
out of plane failure

→ Heritage structures (Slides)
- Wood — light weight structure
  → loss of foundatn
- Walls = panels of bamboos which are plastered
- Random Rubble walls

→ Housing (Slide) — Ikia
Types

} Traditn Housing System

→ Masonry
- Out of plane collapse of wall
- In-plane collapse of wall — window gets separated

(Slides)
- Lack of box action of masonry buildings

→ RCC
- Pancaking : heavy and unyielding floors collapse one atop the other

- Mixed-use buildings
  - collapse of a storey — crushed columns
- Pounding — when buildings are close to each other — they sway during EQ — & hit each other & fall
- short column effect =
- Frame Infill separation
- Ekra over RCC frame plint ✓
- Offset columns
  - not following straight columns

→ RC Building Construct⁾ (slides)

→ Regulatory framework in Gangtok (slides)

→ lifeline structures
- very few damage to bridges
- Maintenance (slides)
- % Bridges

Power Transmission
- damaged due to landslides

Electrical Power (Slides)
- affected communicat^n/water distribution
- Mushrooming of DTH antenna
  - added mass to structure

Communicat^n (Slides)

Critical Structures
- Plinth damages
- Cracks in infills
- Storey collapses

} School (Slides)
- few SE & NSE damages

- frame infill separation

} Hospitals (Slides)

- NSE damage
  - false ceiling
  - Pounding at expansion point

} Governance buildings damaged.

Complete disrupt^n of water supply (Slides)
- Fracture of tank walls

Other NSE damage
- Toppling
- Collapse of light fixature
- Topping of roof top NSE

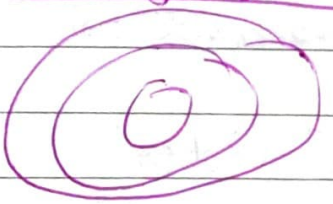
Lessons learned (SLIDES)

- alternate routes
- EQ safety of existing structures after proper assessment
- Cultural Structures
  - lot of sentiments attached
- Formalise dev of traditional structure & giving bank loans for traditional housing construction
- Need for dissemination of technical knowledge
- Capacity building of professionals for new & old constructions (damage assessment teams)
- Release data to local engineers (motion instrument data)
- Education

Formation of Plans (SS DMA) ✱ — SLIDES

Lecture 11 = 18 Feb

Meisoseismicity of EQ



- earthen dams failed
- liquefaction of soil — soil becomes like fluid

Damages (Slides)

predominant period of EQ matches f. period of build. } damage

Lessons Learnt

① GSDMA was set up to implement reconstruction & rehabilitation

② Techno legal regime was tightened
- Revision of building codes
- syllabus Revision of Technical institutions

③ Structural Measures were adopted in terms of
- Hazard Mitigat^{n}
- Preparedness & CB
- Relief & Response
- Administrat^{n} & finance

In Detail =

Structural Measures

a. Formation of GIDM, EOC, NICEE (IIT Kan)
   ISR - Institute of seismological Research
b. Estab. of observatories / Accelerographs

NS Measures (slides)

Relief (slides)

Reconstruct^{n}

- GEERP by GoG - best in country
- Support of Asian Dev. Bank & World Bank
- Recon. & repaired affected houses in record time of 2 yrs.
- Relocation of villages (slide)

(Slides)
→ People were motivated to repair their houses — didn't wait for govt. but there was assistance ~~by~~ from govt

→ Duty was not imposed for building materials produced in Kutch
→ Shake-table demonstrations
→ Prep of guidelines

New Z, Japan, chile, California } > 8M

2010 Chile EQ & Tsunami

→ 1960 - EQ - M9
→ Mainshocks, aftershocks

if peak ground acceleration is more than 1G structure gets lifted & displaced

→ Mass asymmetry
→ Collapses due to stiffness asymmetry — RCC wall one one side of building was creating twisting in building

→ No column — RCC shear walls

Inelasticity / Non-Linear Behavior
→ Main vertical bars buckled & lateral ties broke & concrete fell off

→ Bridges collapsed due to liquefaction

Damages

Lessons Learnt (slides)

① communication systems (Problems in slide)

② Techno legal Regime
↳ strong & stiff structural walls
↳ Laws (slides)

③ Community Awareness (slides)

absence of social control

④ Emergency Management

- no paid firefighters but only volunteers as fire service personnels.
- only paid ppl are drivers & dispatchers
- designated institutes to train volunteers to become firefighters
- NFire Acad. certifies them as a firefighter

Slide

- Preparedness
- Response
  - late in involving Military
- Reconstruction
  - debris removal

2011 Japan EQ & Tsunami

Tsunami comes with a lot of deposits - sediments, soil

- Debris disposal
- Land Reclamation
  - ppl ✗ reluctant
  - land sunk (subsidence)
- Temporary Shelter

→ Fukushima (Nuclear PP)
→ Segregated debris (Debris Management Sys)
  - motorbikes / vehicles
  - wood
  - nets
  - chemical / plastics
  - tyres
  - electronic

Disposal System
- DOCS