URP-302: Urban Hazard and Risk Management

Topic 2:Tropical Cyclone and Tornado

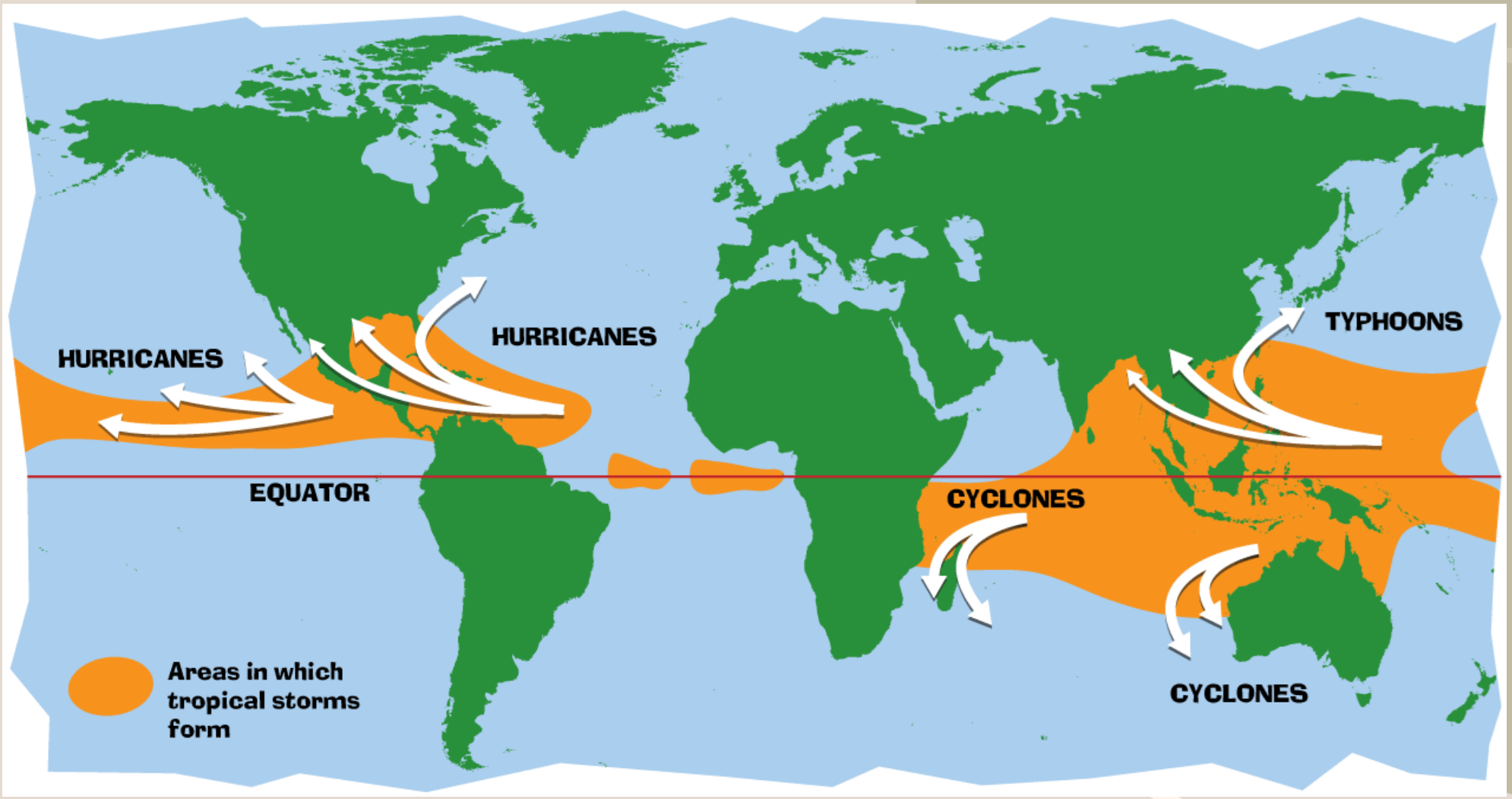
Nafisa Farid Moumi
Lecturer, Department of Real Estate, DIU

Tropical Cyclone

General Characteristics

- Tropical cyclone is a **hydro-meteorological** hazard
- It creates a **low-pressure zone/ depression** around which the air circulates in –
  - Anticlockwise (in the Northern Hemisphere) or
  - Clockwise (in the Southern Hemisphere)
- Normally **circular** in **shape**
- **Diameter:**
  - Narrow cyclone (50-100 km)
  - Large cyclone (up to 2000 km)
- **Wind speed** progressively **increases inward.** The average track speed is 10-50 km/h.
- Average **duration**: 9 days
- Accompanied by heavy rain and high wind.

Global Distribution of Tropical Storms



Structure

i) Eye:

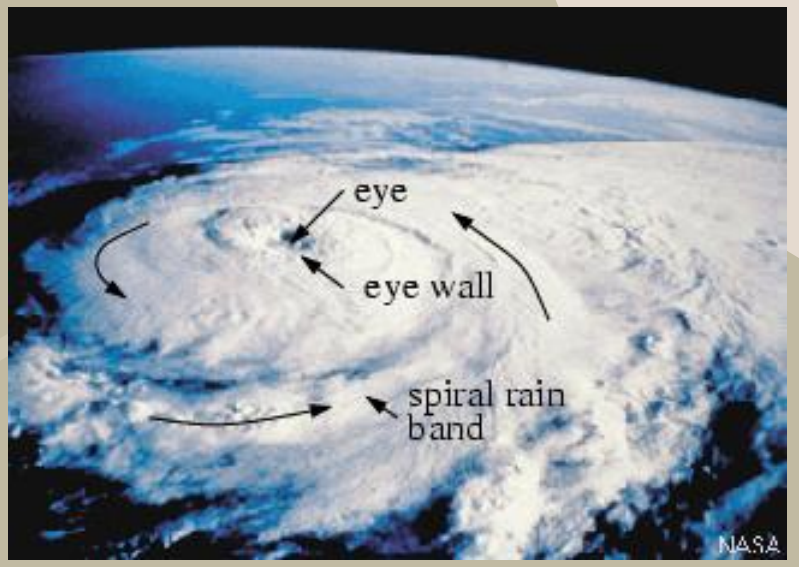
- Extremely low-pressure zone
- Average diameter: 20-30 km
- It is a region of light wind and a small amount of cloud.

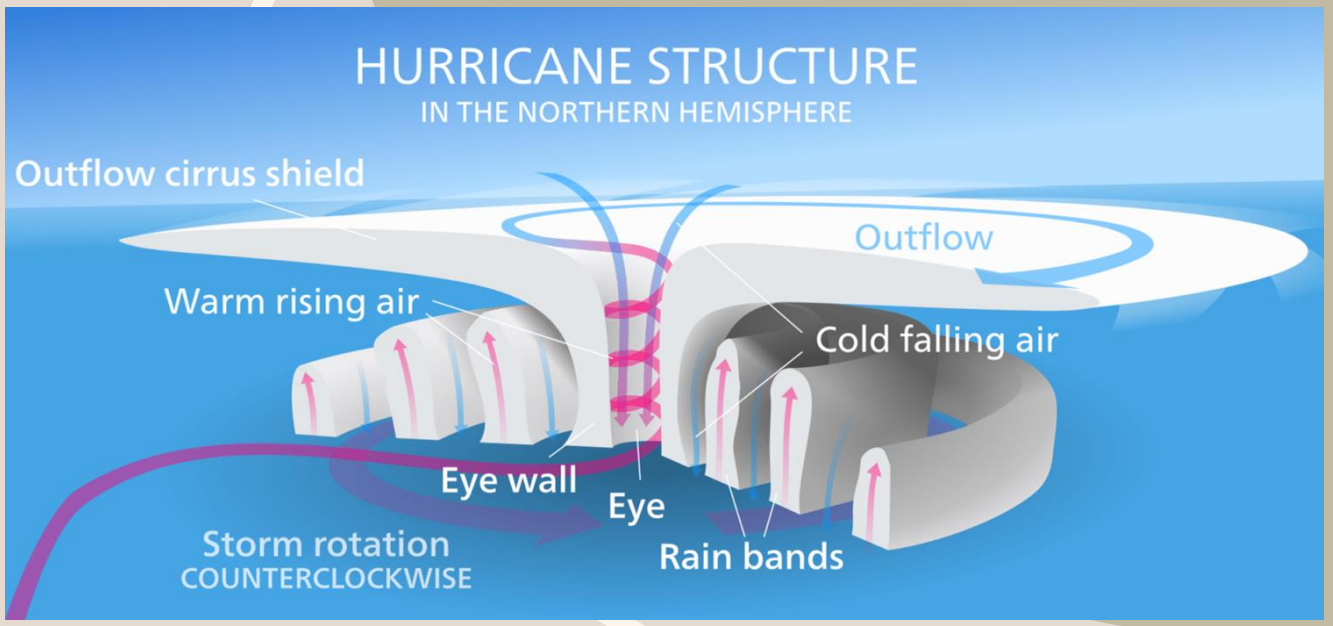
ii) Eye Wall:

- A ring of very strong wind
- Average diameter: 100-300 km
- Most dangerous area (strong wind and rain)

iii) Rain Band:

- Group of clouds that travel away from the eye in a spiral motion
- Rotate and help the storm to circulate





Cyclone Formation

Climatic conditions necessary for cyclone formation:

- Warm sea **temperature** for evaporation (at least **26° C**)
- High **humidity** (for the formation of clouds)
- **Variation** in temperature and pressure (for creating the spiraling effect)
- Location: at least **5° latitude from the equator** (to allow the influence of the Coriolis effect)

Formation process:
https://www.youtube.com/watch?v=UKL9NIxLIIE

Process of dissipation:

When a cyclone moves across the coastline over to land, it loses its source of energy and begins to dissipate.

Cyclone Naming

Since 2004, the World Meteorological Organization (WMO) asked each of the eight South Asian countries (North Indian Ocean basin) to submit a list of eight names. In total, they came up with 64 names. Whenever a cyclone forms, a name is picked in order of submission.

NORTHERN INDIAN OCEAN CYCLONE NAMES

Contributors	List 1	List 2	List 3	List 4	List 5	List 6	List 7	List 8
Bangladesh	Onil	Ogni	Nisha	Giri	Helen	Chapala	Ockhi	Fani
India	Agni	Akash	Bijli	Jal	Lehar	Megh	Sagar	Vayu
Maldives	Hibaru	Gonu	Aila	Keila	Madi	Roanu	Mekunu	Hikaa
Myanmar	Pyarr	Yemyin	Phyan	Thane	Nanauk	Kyant	Daye	Kyarr
Oman	Baaz	Sidr	Ward	Murjan	Hudhud	Nada	Luban	Maha
Pakistan	Fanoos	Nargis	Laila	Nilam	Nilofar	Vardah	Titli	Bulbul
Sri Lanka	Mala	Rashmi	Bandu	Viyaru	Ashobaa	Maarutha	Gaja	Pawan
Thailand	Mukda	Khai Muk	Phet	Phailin	Komen	Mora	Phethai	Amphan

Track of Cyclone in Bangladesh

Cyclone in Bangladesh

- Bangladesh is located within 5 latitudes from the equator
- Funnel shaped sea-shore is vulnerable for cyclone
- October-November and April-May most risky months for cyclones.
- Damage occurs mostly in the coastal regions of Khulna, Patuakhali, Barisal, Noakhali, and Chittagong. Also the offshore islands of Bhola, Hatiya, Sandwip, Kutubdia, Maheshkhali, Nijhum Dwip etc.

Tornado

General Characteristics

- Tornado is a **meteorological** hazard
- Violently rotating column of air around **low-pressure** system.
- **Direction:** (Same as a cyclone)- Anticlockwise in the Northern hemisphere, and Clockwise in the Southern hemisphere
- **Circular** in shape
- **Diameter: 80 m to 150 m**
- Can travel only **a few miles** before dissipating
- **Duration:** Average **20 minutes**
- **Timing:** Can happen any time of day/ night, but most tornados occur between **4-9 pm**
- **In Bangladesh, mostly occurred during April-June**

Climatic Condition Necessary for Formation

- **Instability:**
  - Warm and humid lower atmosphere
  - Unusually cooler and humid upper atmosphere
- **Wind Shear:**
  - Changing wind direction

Prediction and Warning:

- Unpredictable
- Size, strength, direction, and duration cannot be predicted
- **Tornado Warning:** Identify spot with favorable conditions for a tornado by radar and warn people living in the surrounding area

Intensity and Warning

Two scales are commonly used:

- Based on only wind speed- **TORRO (T-scale)**
- Based on both wind speed & damage: **Fujita Scale (F0-F5) & Enhanced Fujita Scale (EF0-EF5)**

SCALE	WIND SPEED	POSSIBLE DAMAGE	Enhanced, Operational Fujita Scale
F0	40-72 mph	Light damage: Branches broken off trees; minor roof damage	EF0 65-85 mph
F1	73-112 mph	Moderate damage: Trees snapped; mobile home pushed off foundations; roofs damaged	EF1 86-110 mph
F2	113-157 mph	Considerable damage: Mobile homes demolished; trees uprooted; strong built homes unroofed	EF2 111-135 mph
F3	158-206 mph	Severe damage: Trains overturned; cars lifted off the ground; strong built homes have outside walls blown away	EF3 136-165 mph
F4	207-260 mph	Devastating damage: Houses leveled leaving piles of debris; cars thrown 300 yards or more in the air	EF4 166-200 mph
F5	261-318 mph	Incredible damage: Strongly built homes completely blown away; automobile-sized missiles generated	EF5 over 200 mph

Disaster Risk Reduction

Cyclone

Structural	Non-structural
Cyclone shelter	Coastal afforestation
Coastal embankment	Public awareness
Improving housing condition	Community preparedness

Tornado

Structural	Non-structural
Tornado shelter	Public awareness
Improving housing condition	Community preparedness

Cyclone Shelter Design Consideration

Sustainable use of Cyclone Shelters:

- The cyclone shelters should be **multi-purpose.** Cyclone shelters are used for a short period of time (during the natural disasters). If these shelters are unused for rest of the year, they will not sustain due to lack of maintenance.
- Usually these buildings are used as **community centre or school** in normal situation, and used as shelter during emergency situation. Using the shelters as office/ hospitals is discouraged, as these cannot be relocated during hazards. On the other hand, primary schools use mats or low height benches for children which can be moved easily.
- The cyclone shelters should be **multi-hazard resistant** (cyclone, flood, storm surge, earthquake etc.). It will increase the life of the structure as well as enhance economic efficiency.
- **Involve the local community** in building and maintaining the shelters.

Cyclone Shelter Design Consideration

Number, Capacity and Location of Cyclone Shelters:

- Number of cyclone shelter depends on number of vulnerable population, and availability of multi-storied and elevated buildings in the area. On an average, **50-60%** people of the vulnerable location use cyclone shelters.
- In most Asian countries, 2 sqft/person area is provided for sheltering purpose. But such density leads to suffocation. Usually a four room school can accommodate around **1000 persons** (*considering 3 sqft/person).*
- The shelters should be located on elevated land (if available). To protect the foundation of the shelter, it should maintain suitable distance from the mangrove belt.

Cyclone Shelter Design Consideration

Building Standard for Cyclone Shelters:

- RCC or brick masonry multi-storied building is encouraged. Building height depends on storm tide levels.
- Doors should open outwards
- Louver type window suggested, made with non-breakable Fiber Reinforced Plastics
- 1 m gap should be ensured between ground and high tide level
- Parapet should be provided all around the roof.
- Stair width should be atleast 1.5 m-2 m. Multiple entry is encouraged.
- Alternative ramp should be provided to carry elder and disabled people.

Cyclone Shelter Design Consideration

Other facilities:

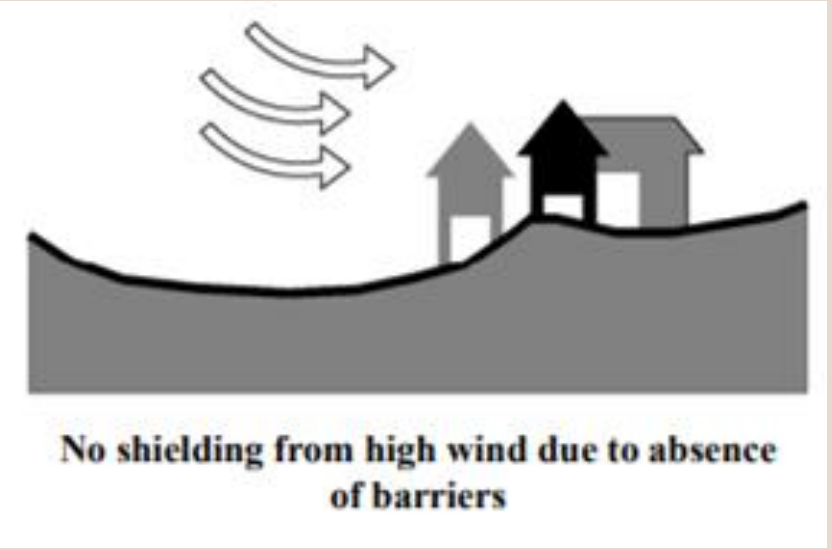
- Provide at least two water tanks with a capacity of minimum 2000 litres each.
- Provide at least two male and two female toilets. Preferable toilet size is 12 sqft.
- Septic tanks should be provided. Tanks should be sealed and elevated (if possible to prevent inundation during flooding.
- Provide appropriate power back up facilities such as generator/ solar power cells.
- Communication facilities such as wireless radios/ walkie-talkies may be provided


Parapet Wall

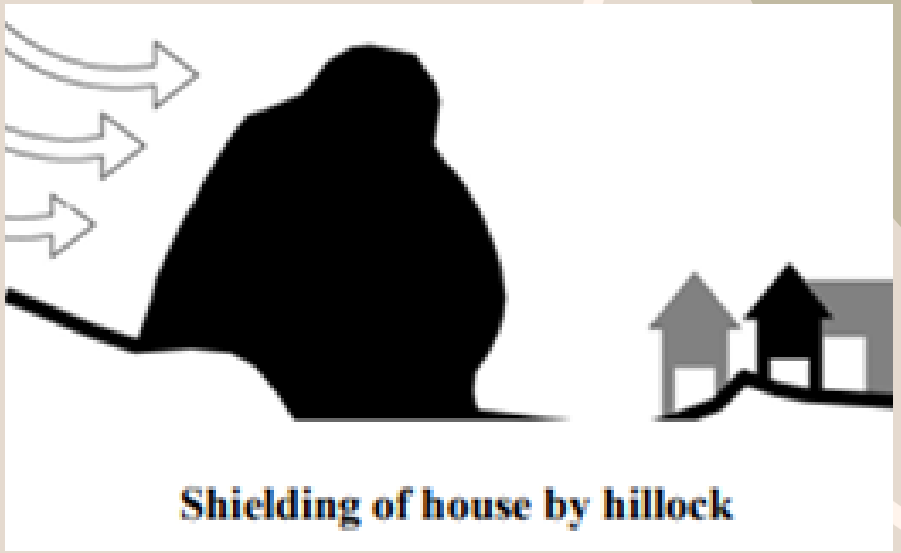
Construction considerations for Cyclone

Choosing a site:

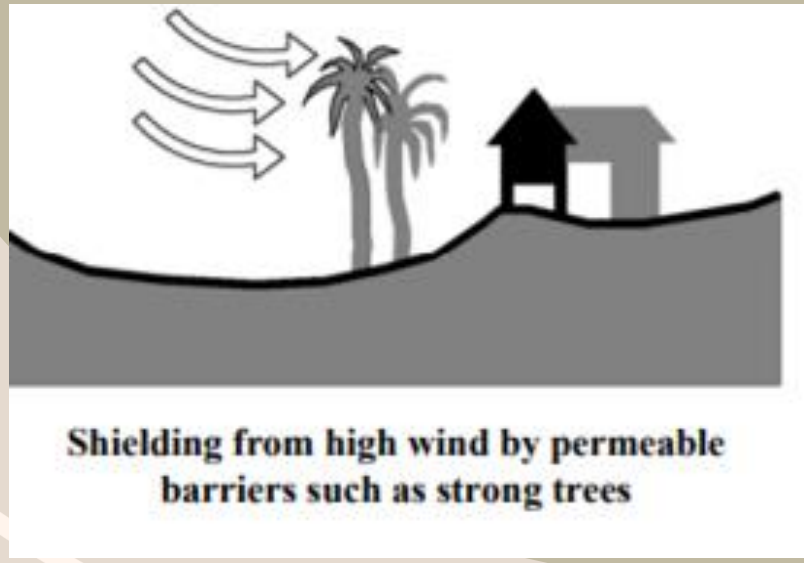
- Area behind mound/hillocks are preferred to provide natural shielding.
- Row of trees can also act as a shield. The influence of tree shield is limited to a distance of 8-10 times of the tree height. To prevent the house from broken tree, at least a distance of 1.5 times of the tree height should be maintained.



No shielding from high wind due to absence of barriers



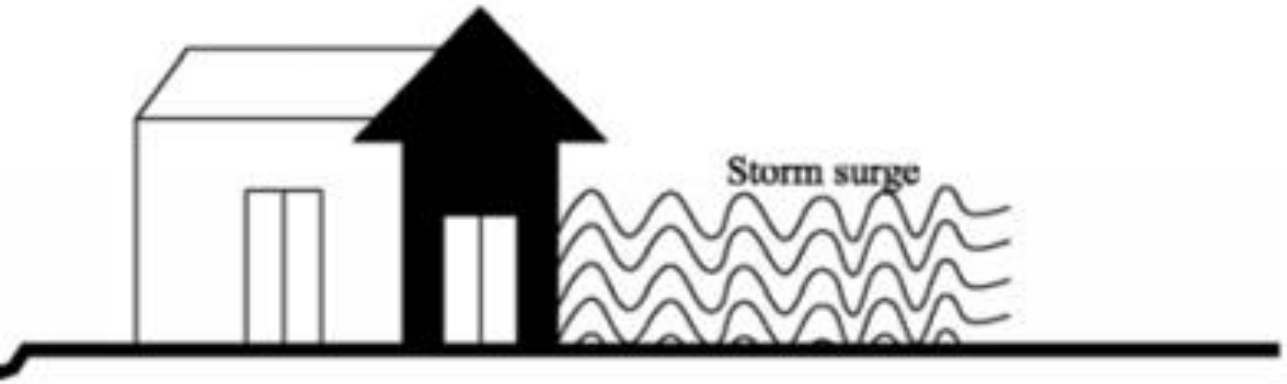
Shielding of house by hillock



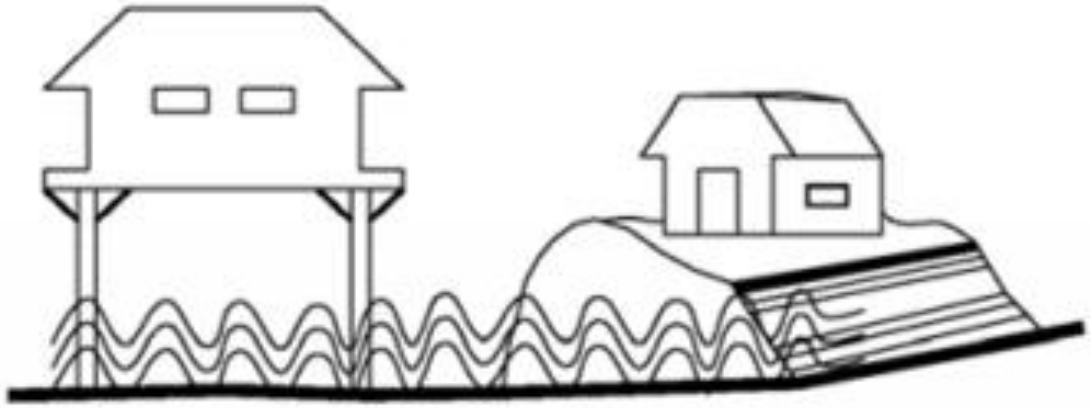
Shielding from high wind by permeable barriers such as strong trees

Construction considerations for Cyclone

- As cyclone usually causes storm surge, construction at ground level has risk of inundation.
- Construction on stilts or artificially raised mounds are preferred.



Construction at ground level risk of inundation

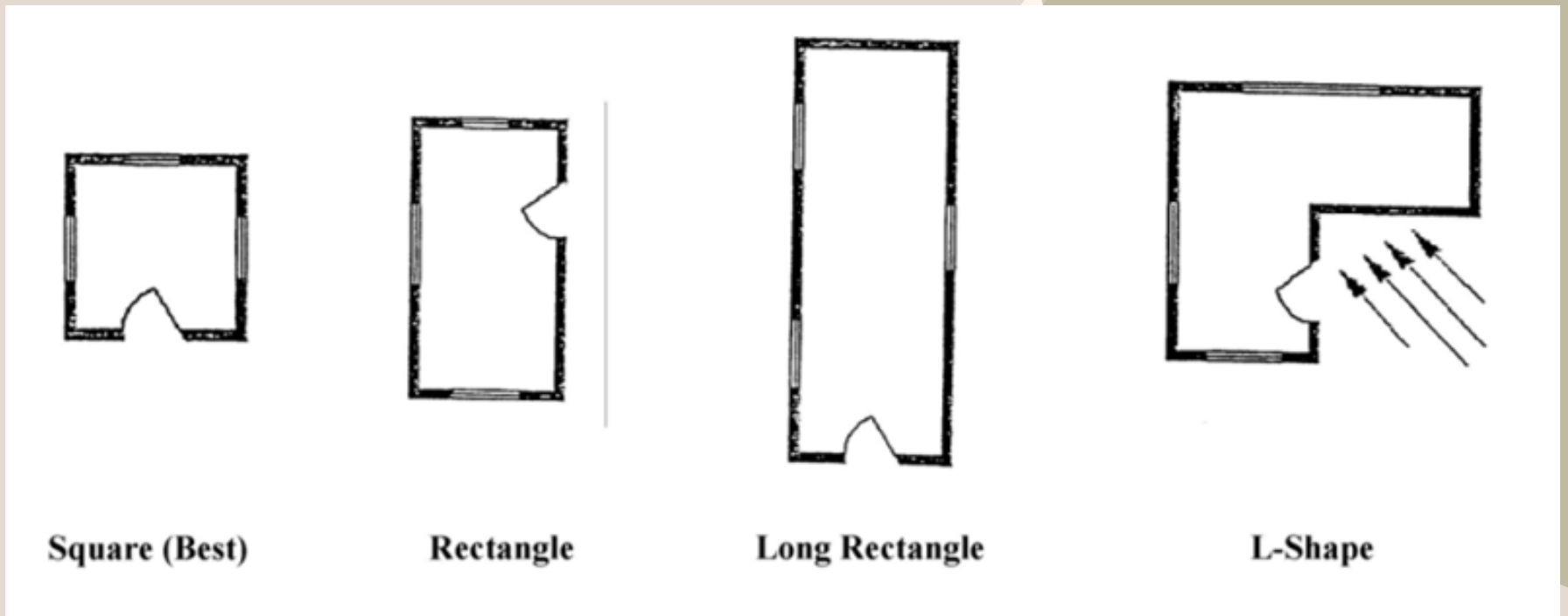


Construction on stilts or artificially raised earth mounds

Construction considerations for Cyclone

Building Shape:

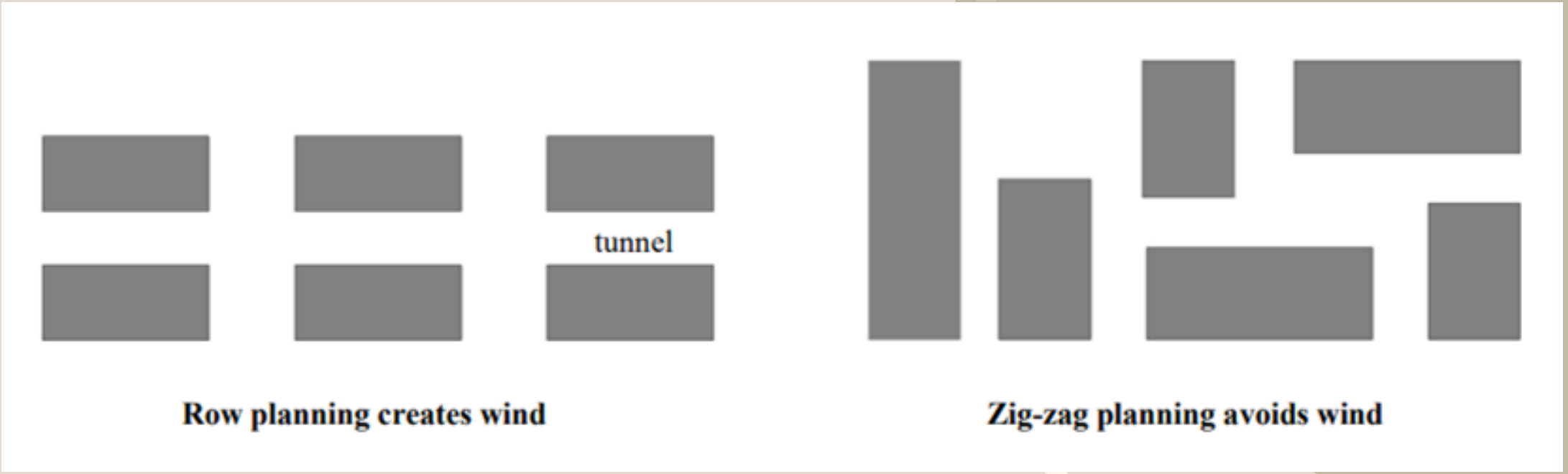
- Simple, compact and symmetrical shapes are more resistant to cyclone.
- The square plan is better than the rectangle, and rectangle is better than the L-shaped plan



Construction considerations for Cyclone

Building Pattern:

- In case of construction of group of buildings, a cluster arrangement/ zigzag pattern is more preferred than row type.

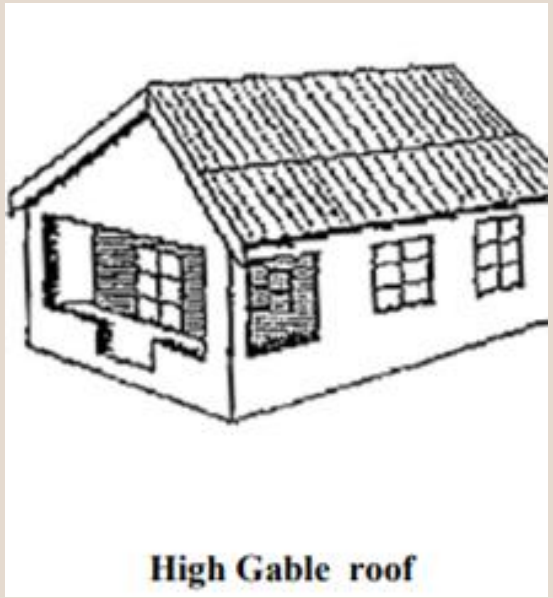


Construction considerations for Cyclone

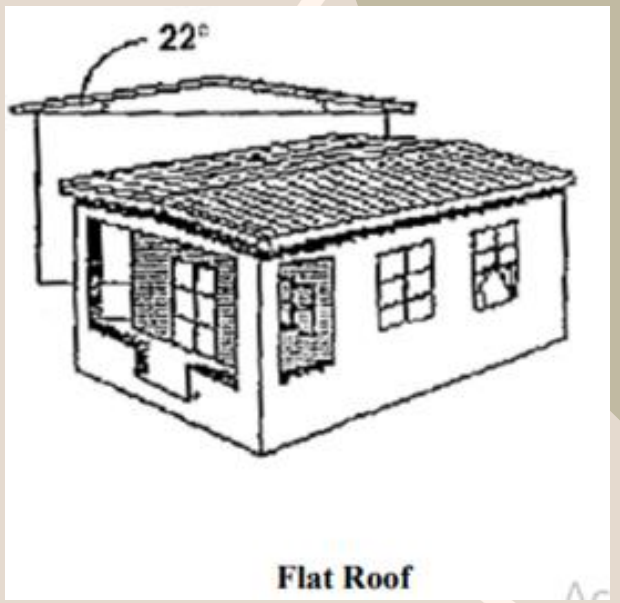
Roof Design:

- Avoid low pitched roof (should not be less than 22°).
- Use hip roof or high pitched gable roof.
- Avoid overhanging roofs. Overhangs should not be more than 18 inches.

Hip Roof



High Gable roof

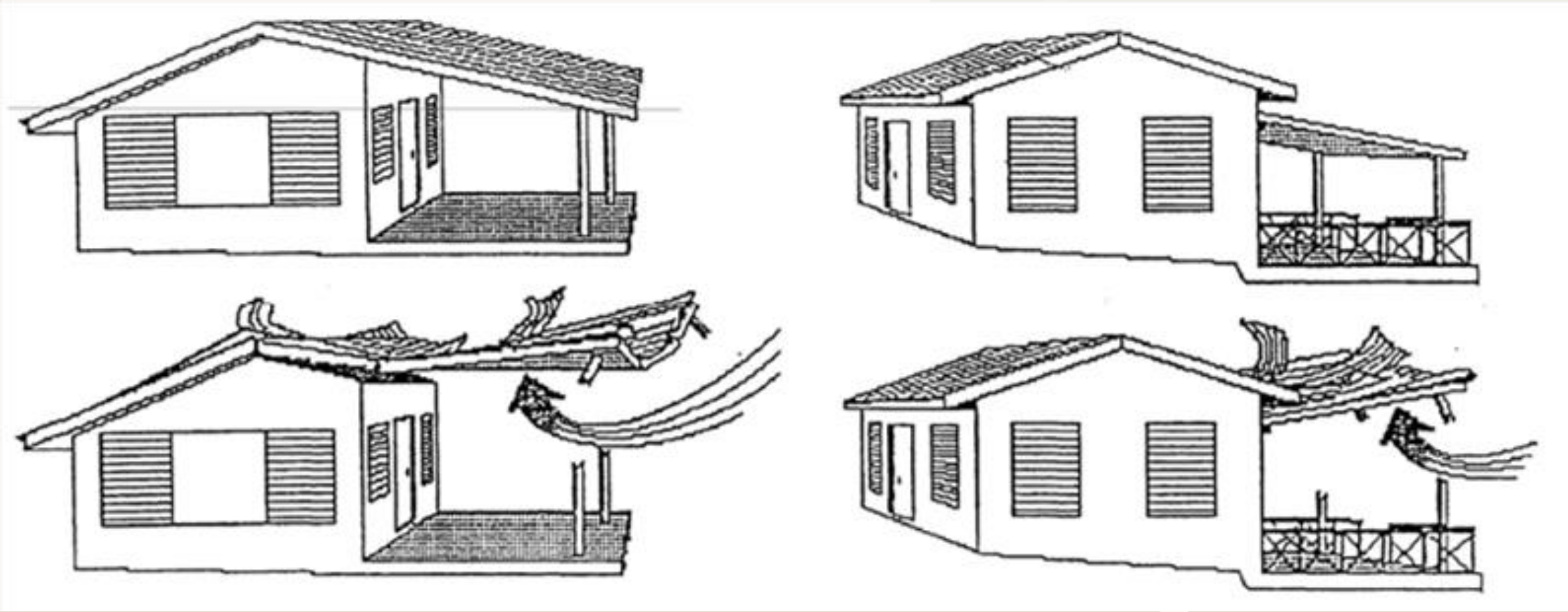


Flat Roof

Overhanging roof

Construction considerations for Cyclone

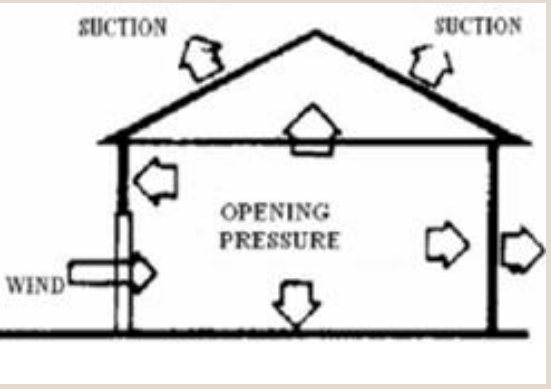
Build veranda or patio roofs as **separate structure** rather than **extension** of the main building. They may blow off without damaging the rest of the house.

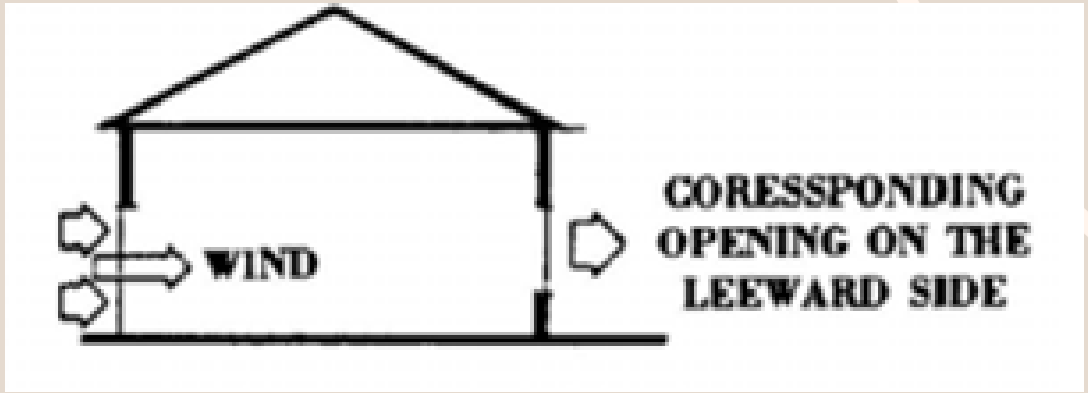


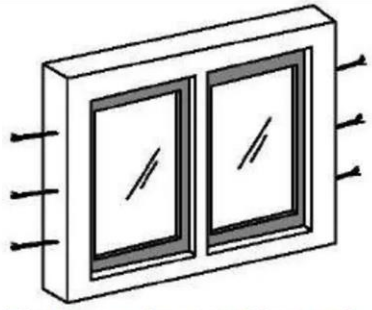
Construction considerations for Cyclone

Doors and Windows:

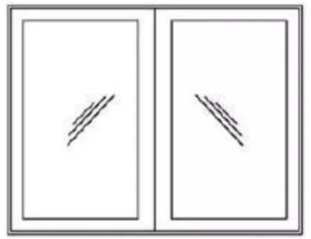
- Opening on the windward side during a cyclone will increase the pressure on the internal surfaces. This pressure may cause the roof to blow off and the walls to explode. To reduce this pressure, **corresponding opening on leeward side** should be provided.
- **Adequate anchorage** of doors and window frames should be provided.
- Use **thicker glass pane** or strengthen the glass by pasting thin paper strips.



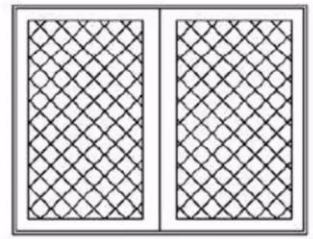




Adequate anchorage of door and window frames with holders



Large and thin unprotected glass areas in windows



Glass protection by adhesive tapes

Thank you