Uttarkashi Tunnel Collapse

For Prelims: Silkyara-Barkot Tunnel, **Char Dham Project,** National Highways and Infrastructure Development Corporation Ltd, Drill and Blast Method, Atal Tunnel, Pir Panjal Railway Tunnel, Dr Syama Prasad Mookerjee Road Tunnel.

For Mains: Issues Related to Tunnel Construction in India, Challenges Related to Indian Himalayan Region.

Source: TH

Why in News?

Recently, an under-construction **Silkyara-Barkot tunnel** along the **Yamunotri National Highway in Uttarkashi district, Uttarakhand,** collapsed, trapping a significant number of workers inside.

- The incident raises concerns about **tunnel construction**, prompting closer examination of **potential causes and preventive measures.**

What Could be the Potential Cause of Tunnel Collapse?

- **About:**
  - The **Silkyara-Barkot tunnel** is part of the ambitious **Char Dham all-weather road project** of the Central Government.
  - The construction of the tunnel was tendered to **Hyderabad-headquartered Navayuga Engineering Company** by the **National Highways and Infrastructure Development Corporation Ltd (NHIDCL)**, a fully owned company of the Ministry of Road Transport & Highways, Government of India.
- **Potential Causes of Tunnel Collapse:** The exact cause of the tunnel collapse is yet to be ascertained, but a possible factor could be:
  - The collapsed section, **situated around 200-300 meters from the tunnel mouth,** might have contained a **hidden loose patch** of fractured or weak rock, undetectable during construction.
  - Water seepage through this compromised rock could have **eroded it over time, creating an unseen void atop the tunnel structure.**

What are the Critical Aspects of Tunnel Construction?

- **Tunnel Excavation Techniques:**
  - **Drill and Blast Method (DBM):** Involves **drilling holes into rock** and detonating explosives to break it apart.
    - DBM is often used in regions like the **Himalayas (Jammu & Kashmir and Uttarakhand)** due to the challenging terrain.
  - **Tunnel-Boring Machines (TBMs):** It bore through rock while supporting the tunnel behind with precast concrete segments. It is a more expensive but safer method.

        - TBMs are ideal when the rock cover is up to 400 metres tall. Underground tunnels for the Delhi Metro were dug using a TBM at shallow depth.
- **Aspects in Tunnel Construction:**
    - **Rock Investigation: Thoroughly examining the rock's strength and composition through seismic waves and petrographic analysis** to assess its load-bearing capacity and stability.
    - **Monitoring and Support:** Continuous **monitoring using stress and deformation meters,** along with various support mechanisms like **shotcrete, rock bolts, steel ribs, and specialized tunnel pipe umbrellas.**
    - **Geologist Assessments:** Independent geologists play a crucial role in examining the tunnel, **predicting potential failures,** and determining the rock's stability duration.

What are the Other Major Tunnels in India?

- **Atal Tunnel: Atal Tunnel (also known as Rohtang Tunnel)** is a highway tunnel built under the **Rohtang Pass in the eastern Pir Panjal range** of the Himalayas on the **Leh-Manali Highway in Himachal Pradesh,** India.
    - At a length of 9.02 km, it is the **longest tunnel above 10,000 feet (3,048 m) in the world.**
- **Pir Panjal Railway Tunnel:** This 11.2 km long tunnel is **India's longest transportation railway tunnel.**
    - It runs through the Pir Panjal mountain range between **Quazigund and Baramulla.**
- **Jawahar Tunnel:** It is also called Banihal Tunnel. The length of the tunnel is 2.85 km.
    - The tunnel facilitates round-the-year road connectivity between **Srinagar and Jammu.**
- **Dr Syama Prasad Mookerjee Road Tunnel:** It was previously known as Chenani-Nashri Tunnel and is the longest road tunnel of India.The length of this road tunnel is **9.3 km.**

Way Forward

- **Regular Maintenance:** Implement a stringent maintenance schedule, including **inspections for structural integrity, drainage systems, and ventilation** to identify and rectify issues promptly.
    - Employ **sensors and monitoring technologies to continuously assess structural health,** detecting any potential weaknesses or anomalies early.
- **Risk Assessment and Preparedness:** Conducting third party risk assessments periodically, considering **geological, environmental, and usage factors.**
    - Developing contingency plans and emergency protocols in case of any structural concerns.
- **Training and Awareness:** Training personnel in **tunnel management and emergency response procedures.** Public awareness campaigns can educate users and nearby residents about safety measures and reporting mechanisms.
- **Technology Integration:** Explore innovative technologies like **Artificial Intelligence, drones, or robotics for more efficient inspections,** maintenance, and early detection of potential issues.