Strengthening of Geodetic Reference Frame For Defence Applications

Geodesy and Earth Measurements

Definition and Importance of Geodesy

Geodesy measures Earth's shape and size in a 3D time- varying space caused by internal and external forces.

Plate Movements and Geodetic Science

Role in Monitoring and Strategic Applications

Plate movements cause deformation; geodesy helps monitor changes for civil infrastructure, military satellites, positioning, and targeting.

Components of Geodetic Infrastructure

Ground Control Points and Related Equipment

Includes ground control points, gravity stations, IGS stations, tide gauges, CORS stations, and necessary geodetic equipment.

Reference Frame Definition

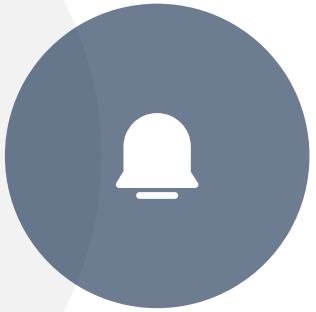
Horizontal, Vertical, Gravity, and Tidal Datum

Reference frame consists of precise horizontal, vertical, gravity, and tidal datums essential for accurate positioning.

Importance of Geodetic Reference Frame in Defence Applications

Military Engineering Applications

Planning and Execution



Geodetic data aids in planning attacks, defensive lines, and logistical routes essential for military operations.

Mapping and Navigation

Strategic Importance

Accurate maps and navigation systems help secure borders and monitor terrain for tactical advantage.

Air Operations

High-Precision Navigation and Targeting

Enables Precision Navigation and Timing (PNT), Weapon Guidance, Targeting, and Satellite Interlinking via satellite-based geospatial intelligence.

Amphibious Operations

Positioning and Targeting Support

Geodesy ensures precise positioning for naval gunfire, troop landings, and airborne units; supports hydrographic and terrain analysis.

Modern Warfare and Space Defence

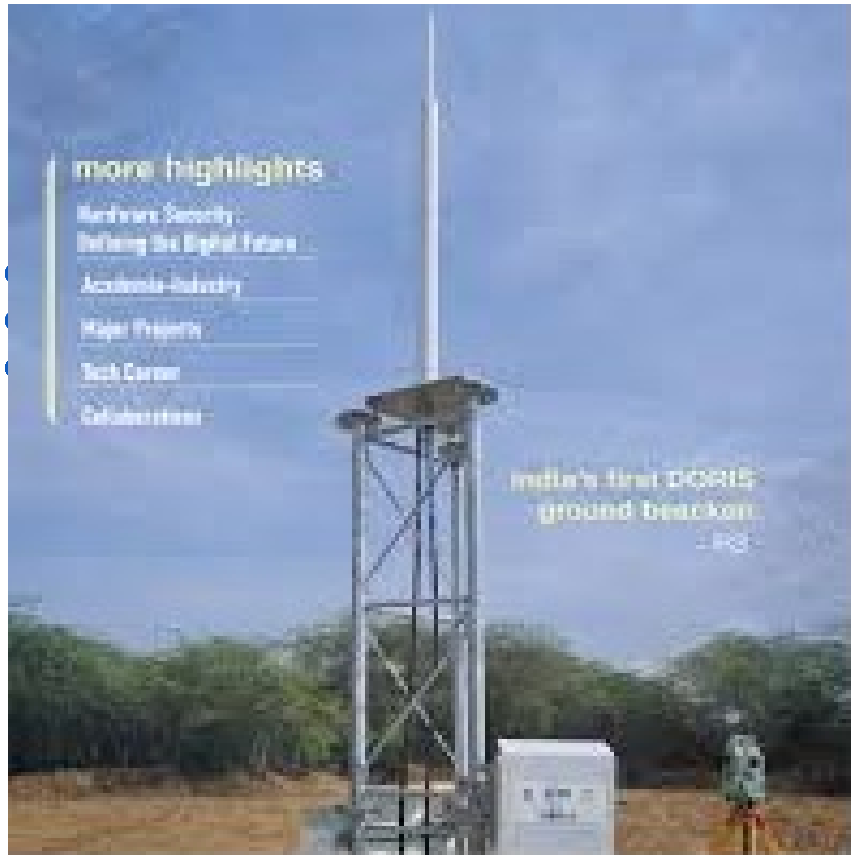
Sudarshan Chakra System and Israel’s Iron Dome

India’s Sudarshan Chakra akin to Israel's system leverages AI and missile tech; depends on classical geodesy and advanced geospatial infrastructure.

Geodetic Infrastructure

DORIS
by
IIT Kanpur

India's First DORIS (Doppler Orbitography and Radio-positioning Integrated by Satellite) Ground Beacon



Located at the National Centre for Geodesy (NCG), IIT Kanpur,

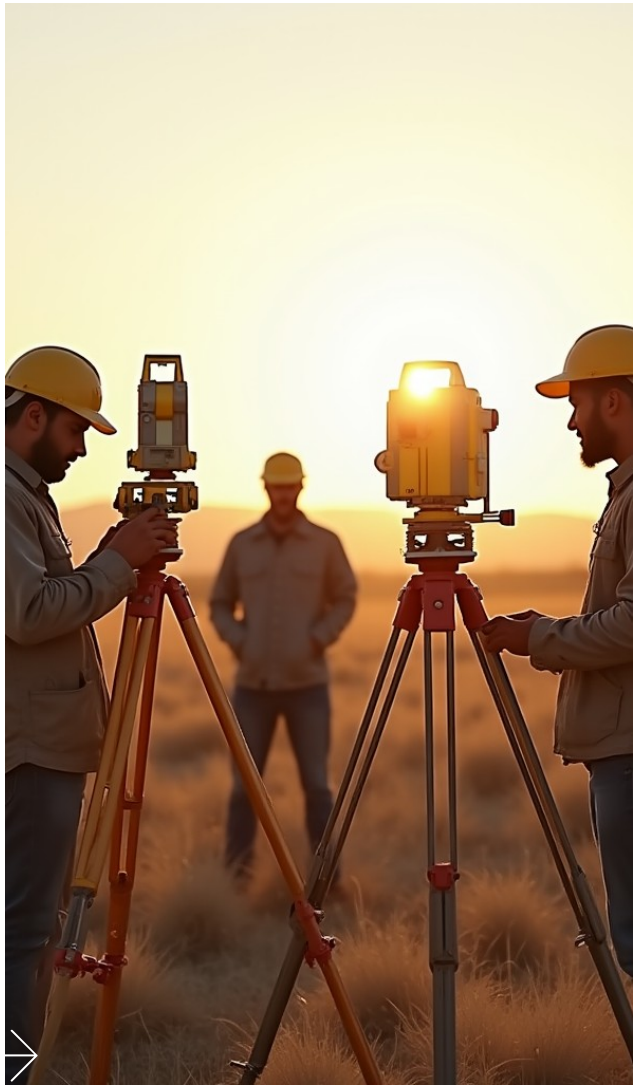
Tracks satellites with centimeter-level accuracy:

- Climate studies
- Ocean altimetry
- Tectonic shift monitoring, and
- Space geodesy.

CORS Network
by
Survey of India

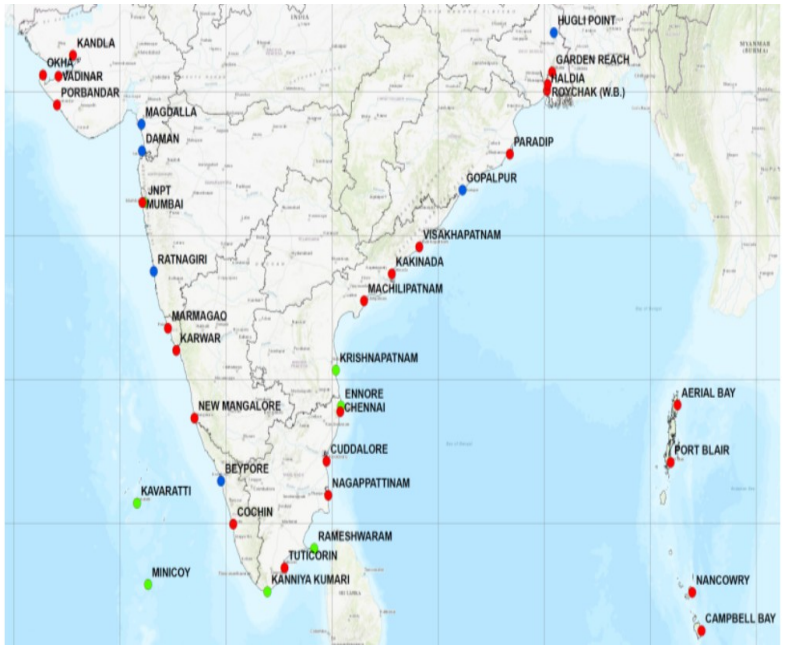
Defining Horizontal Reference Frame

Establishes a precise horizontal geodetic reference framework critical for mapping and navigation



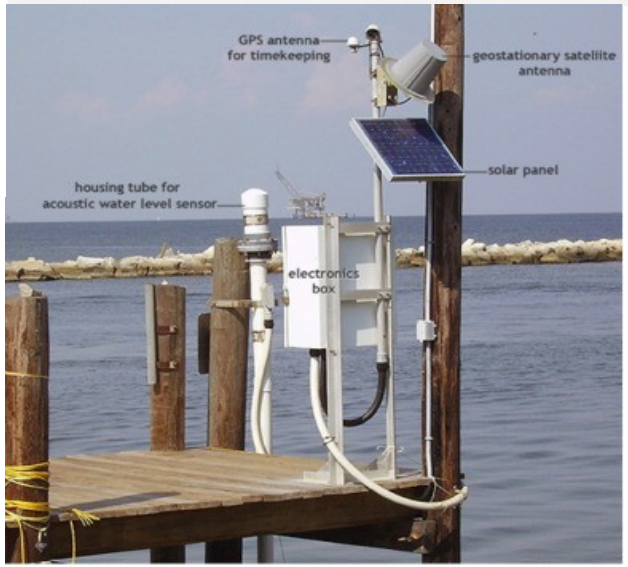
Tidal Reference Frame Infrastructure

Coastal Tide Gauge Network



Joint Operation by SOI and INCOIS (Indian National Centre for Ocean Information Services)

SOI manages geodetic monitoring and tidal predictions; INCOIS integrates data into the Indian Tsunami Early Warning System



Defence Significance

Supports Indian Navy and Coast Guard for safe navigation, amphibious operations, and maritime surveillance.

Gravity Stations for Gravity Reference Frame and Geoid Modelling

Gravity Observations in India

Institutions Involved

Survey of India, National Geophysical Research Institute, and IIT Kanpur map gravitational anomalies.

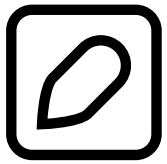
Importance for Defence Applications

Strategic Uses

Critical for Inertial Navigation Systems (INS), Ballistic Missile Targeting, Stealth and Submarine Detection, and Geospatial

Way Ahead

Strategic Long-term Planning



Complexity and Historical Value

India's geodetic network history is invaluable; future plans must ensure cost- efficiency, adaptability, and scalability.

Enhancement Through Airborne Gravimetry

Addressing Terrain Challenges

Airborne gravimetry necessary for dense gravity data due to rough terrain limitations.

Permanent Scientific Group in Defence Forces

Responsibilities and Long-term Contracts

Assess gravity data, sea- level systems, develop airborne measurement strategies, and continuously improve geoid models.

Development of Transformation Algorithms

Linking Old and New Reference Frames

Ensure smooth transformation of legacy maps to new geodetic frames.

Establishing of Defence Centre for Applied Geodesy (DCAG)

Hub for Geodetic Research and Military Participation

DCAG to foster cooperation nationally and internationally with academic support from NCG, IIT Kanpur.

Focus Areas of DCG

01

Research Collaboration

Facilitate military involvement in geodetic networks and initiatives.

02

Promotion of Geodesy in Military Applications

Advance geoinformatics and geospatial sciences research relevant to defence.

03

Capacity Building and Curriculum Development

Implement international-standard curricula and certification programs in geodesy.

04

Consortium Development for Data Standardization

Coordinate national organizations for geodetic data collection, archival, and dissemination aligned with military needs.

Thanks