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A Civil Engineering Magazine

Civil-o-sphere

by Department of Civil Engineering
Technique Polytechnic Institute

- IMPORTANCE OF GREEN CONCRETE
- RIVER BANK EROSION
- **APPLICATION OF GPS AND GIS**
- MIVAN CONSTRUCTION TECHNOLGY
- GROUNDWATER RECHARGE ITS IMPORTANCE AND SOCIO-ENVIRONMENTAL VALUE
- UPGRADATION OF PAVEMENT BY USIG FIBRE- REINFORCED CONCRETE

Vision of Our Institute

To be a premier institute in pursuit of excellence in technical education and skill development committed to serve the society.

Institute Mission Statements

1. **To promote excellence in learning, teaching and technology transfer.**
2. **To improve the quality of skilled workforce through a structured programme and professional skills training.**
3. **To inspire students to learn and facilitate their overall development with social orientation and values.**

Vision of the department:

To become excellent in the field of Civil Engineering in developing highly competent technically skilled manpower to meet the current and future challenges.

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1. To impart quality education and consultancy services to the community in all areas of Civil engineering.

2. To impart knowledge with emphasis on the development of leadership qualities among students in a congenial learning environment.

3. To impart knowledge and to equip students with skills to prepare them for successful diverse professional career.

4. To promote among the students attitude to serve society and the nation by providing solutions to the challenges in the field of Civil Engineering.

5. To provide opportunities to students and faculty members to innovate and disseminate knowledge.

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Contents

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Importance Of Green Concrete

By – Mrs. Sayantika Saha
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A Green Concrete is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998. Green concrete has nothing to do with color. It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design to structural design, construction, and service life.

Green concrete is very often also cheap to produce because for example, waste products are used as a partial substitute for cement, charges for the disposal of waste are avoided, energy consumption in production is lower, and durability is greater. Green concrete is a type of concrete which resembles the conventional concrete but the production or usage of such concrete requires minimum amount of energy and causes least harm to the environment. The CO2 emission related to concrete production, is between 0.1 and 0.22 t per tonne of produced concrete

1. INTRODUCTION

What Is Green Concrete?

Concrete which is made from concrete wastes that are eco-friendly are called as **"Green concrete".** Green concrete is the production of concrete using as many as recycled materials as possible and leaving the smallest carbon footprint as possible**.** The other name for green concrete is resource saving structures with reduced environmental impact for e.g. Energy saving, co2 emissions, waste water.

"Green concrete" is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998 by Dr. WG.

Concrete wastes like slag, power plant wastes, recycled concrete, mining and quarrying wastes, waste glass, incinerator residue, red mud, burnt clay, sawdust, combustor ash and foundry sand.

Green Concrete is a term given to a concrete that has had extra steps taken in the mix design and placement to insure a sustainable structure and a long-life cycle with a low maintenance surface e.g. Energy saving, CO2 emissions, waste water.

The goal of the Centre for Green Concrete is to reduce the environmental impact of concrete. To enable this, new technology is developed. The technology considers all phases of a concrete construction's life cycle, i.e. structural design, specification, manufacturing and maintenance, and it includes all aspects of performance, i.e.

- Mechanical properties (strength, shrinkage, creep, static behavior etc.)
- Fire resistance (spalling, heat transfer etc.)
- Workmanship (workability, strength development, curing etc.)
- Durability (corrosion protection, frost, new deterioration mechanisms etc.)
- Thermodynamic properties (input to the other properties)
- Environmental aspects (CO2-emission, energy, recycling etc.)

2. SUITABILITY OF GREEN CONCRETE IN STRUCTURES

Several factors which enhances the suitability of green concrete in structures includes:

-
- Reduce the dead load of the structure and reduce the crane age load; allow handling, lifting flexibility with lighter weight.
- Reduction of emission of CO□ by 30%.
- Increased concrete industries use of waste products by 20%.
- Good thermal and fire resistance, sound insulation than the traditional concrete.
- Improve damping resistance of the building.
- Use of new types of residual products, previously land filled or disposed of in other ways.
- No environmental pollution and sustainable development.
- It requires less maintenance and repairs.
- Compressive strength behavior of the concrete with water cement ratio is more than that of conventional concrete.
- Flexural strength of the green concrete is almost same as conventional concrete.
- CO2-neutral, waste-derived fuels shall substitute fossil fuels in the cement production by atleast 10 %.
- Use of concrete industries own residual products.

3. Here Is A List Of 4 Benefits To Using Green Concrete

Lasts Longer: Green concrete gains strength faster and has a lower rate of shrinkage than concrete made only from Portland cement. Structures built using green concrete have a better chance of surviving a fire (it can withstand temperatures of up to 2400 degrees on the Fahrenheit scale). It also has a greater resistance to corrosion which is important with the effect pollution has had on the environment (acid rain greatly reduces the longevity of traditional building materials). All of those factors add up to a building that will last much longer than one made with ordinary concrete. Similar concrete mixtures have been found in ancient Roman structures and this material was also used in the Ukraine in the 1950s and 1960s.

Uses Industrial Waste: Instead of a 100 percent Portland cement mixture, green concrete uses anywhere from 25 to 100 percent fly ash. Fly ash is a byproduct of coal combustion and is gathered from the chimneys of industrial plants (such as power plants) that use coal as a power source. There are copious amounts of this industrial waste product. Hundreds of thousands of acres of land are used to dispose of fly ash. A large increase in the use of green concrete in construction will provide a way to use up fly ash and hopefully free many acres of land.

Reduces Energy Consumption: If you use less Portland cement and more fly ash whenmixing concrete, then you will use less energy. The materials that are used in Portland cement require huge amounts of coal or natural gas to heat it up to the appropriate temperature to turn them into Portland cement. Fly ash already exists as a byproduct of another industrial process so you are not expending much more energy to use it to create green concrete.

Another way that green concrete reduces energy consumption is that a building constructed from it is more resistant to temperature changes. An architect can use this and design a green concrete building to use energy for heating and cooling more efficiently.

Reduces CO2 Emissions: In order to make Portland cement–one of the main ingredients in ordinary cement–pulverized limestone, clay, and sand are heated to 1450 degrees C using natural gas or coal as a fuel. This process is responsible for 5 to 8 percent of all carbon dioxide (CO2)

emissions worldwide. The manufacturing of green concrete releases has up to 80 percent fewer CO2 emissions. As a part of a global effort to reduce emissions, switching over completely to using green concrete for construction will help considerably

4. CONCLUSION

- The tests were conducted and the observed values are concluded as follows:

- We can replace cement by glass safely up to 30%and little more but we cannot replace it by 45 % & more.

- We can replace cement by (glass + fly ash) up to 30% but we cannot replace it by 45 % & more.

- 28 days strength obtain from (glass + fly ash) is more than 28 days strength of glass replacement.

- On strength, criteria by glass + fly ash replacement is better than by only glass-replacement.

- It reduces the CO2 emission up to 30%

- At 15% replacement by glass powder strength came 24.2% more than normal concrete.

- At 30% replacement strength came 5.37% more than normal concrete

- At 15 % replacement by (glass +fly ash) strength came 34 % more than normal concrete.

- At 30% replacement by glass + fly ash strength came 6.48% more than normal concrete.

River Bank Erosion

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Introduction

Bank erosion is a natural geomorphic process or disturbance that occurs during or soon after floods. Riverbanks are transitional boundaries, or ecotones, between the aquatic and terrestrial ecosystems, and they frequently change under naturally dynamic hydrologic conditions. Although abundant evidence suggests that bank erosion is a necessary ecological process (Pie gay et al. 1997, 2005), current river management, and sometimes even restoration strategies, calls for channel bank infrastructure, that is, hard structural elements intended to arrest bank erosion (also called revetment, erosion control, or bank stabilization structures). Such strategies often focus on human values that include property damage and land loss, flood hazards (Pie gay et al. 1997, Casagli et al. 1999), and potential impacts to aquatic habitat from bank-derived fine sediment contributions (EPA 2007). Often, projects labeled as "restoration" focus principally on bank stabilization. However, static banks are not the norm, and static rivers and streams do not sustain ecosystems. Despite this, in response to the notion that bank erosion is deleterious, the construction of bank infrastructure has become pervasive over the past century as an increasing population and associated development encroach on riparian landscapes. Thus, bank erosion management is a significant ecological issue.

Geomorphic and Ecologic Significance of Banks and Bank Erosion

We define "riverbank," in a geomorphic context, as the land-form distinguished by the topographic gradient from the bed of a channel along the lateral land-water margin up to the highest stage of flow or up to the topographic edge where water begins to spread laterally over the flood plain surface. Bank erosion refers to the erosion of sediment from this distinct landform. Eroded sediment moves along the topographic gradient laterally toward the channel or in the downstream direction. Banks are often characterized by bare sediment, live vegetation, or snags (Roy et al. 2003). In an ecological context, riverbanks are an important component of riparian zones. Bank habitat and function are to some degree inseparable from functions within the larger riparian zone; here we take a broader view of natural banks and bank erosion as they influence riparian areas. Ecologically functioning riparian zones provide a variety of resources and are vital centers of biodiversity (Gregory et al. 1991, Naiman et al. 1993, 2005, Ward and Tockner 2001, NRC 2002). The main functions of riparian zones are related to fluvial hydrology and sediment dynamics; retention and cycling of nutrients and pollutants; and maintenance of habitat for wildlife, including invertebrates, amphibians, reptiles, birds, and mammals (NRC 2002). In the following sections, we review elements of banks and bank erosion that create physical and biological heterogeneity and riparian diversity. We focus discussion of bank processes and functions around principles that illustrate the significance of bank erosion and natural banks as desirable attributes of rivers: Channel banks form a significant ecotone between aquatic and terrestrial ecosystems with diverse structure and

habitat functions; this article forms the critical basis for discussions of the effects of and alternatives for channel bank infrastructure.

- Bank erosion provides a sediment source that creates riparian habitat.
- Active banks create and maintain diverse structure and habitat functions.
- Riparian vegetation promotes bank stability and contributes large woody debris.
- Bank erosion modulates changes in channel morphology and pattern.

Causes

River bank erosion occurs both naturally and through human impact. Rivers and streams are dynamic systems as they are constantly changing. The natural process of riverbank erosion can produce favorable outcomes such as the formation of productive floodplains and alluvial terraces. Some stable rivers have a healthy amount of erosion; however, unstable rivers and the erosion taking place on those banks are a cause for concern.

The two broad types of river bank erosion are:

1. Bank Scour: Involves the removal of bank material by flowing water and carried sediment. Look for undercutting of the bank toe as a sign of scour and mass failure.

2. Mass Failure: Characterized by sections of the bank sliding or toppling into the stream. Look for bare and near-vertical banks as a sign of collapse.

River Bank erosion has several causes with even more factors that can accelerate it. The major causes are flooding, land use, stream management, over-clearing of catchment and stream bank vegetation, and poorly managed sand and gravel extraction.

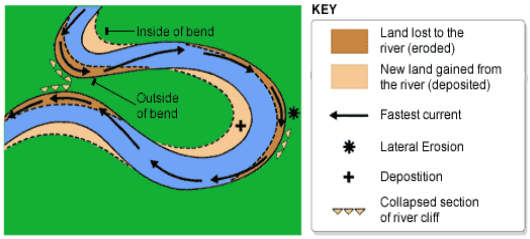
Factors That Cause Erosion:

- Stream bed lowering or in fill
- Flooding of bank soils followed by rapid drops in flow
- Saturation of banks from off-stream source
- Redirection and acceleration of flow within the channel
- Poor Soil Drainage
- Wave Action
- Excessive Sand/Gravel Extraction
- Intense Water from Rainfall

There are four main processes that contribute to bed erosion:

- Decrease in sediment supply. This can occur when the natural passage of sediment through the system is interrupted by upstream dams, weirs, catchment erosion control works, or excavations in the streambed.
- Increase in bed slope. This can be as a result of straightening the river, removing a bed control such as a rock bar, weir or crossing, or excavating the bed of the river for extractive industries, recreation or large pump holes.
- Increase in velocity (not associated with an increase in slope). This can be as a result of a channel constriction such as debris, fill, and vegetation on the riverbed or bridge abutments.
- Increase in discharge. This can be as a result of increased urban run-off, catchment clearing or increases in rainfall. It can also be from regulated water transfers for irrigation supplies.

Fluvial erosion occurs during floods when the near-bank flow velocity and acceleration exert shear stress on the banks that is greater than the



critical shear stress needed to entrain bank sediment. Fluvial erosion frequently scours the toe of the bank, causing the upper portion to collapse. The relation between the rate of sediment supply from bank erosion and the rate of fluvial transport of this material from the base of the bank controls the rate of bank retreat. Floods that cause erosion are stochastic, and local field conditions—as well as human modifications—are highly non uniform. Thus, measurement and prediction of long-term erosion rates is complex; in practice, there are numerous challenges in extrapolating temporal and spatial scales of bank erosion .Fluvial erosion of bank sediment may expose tree roots or undercut and destabilize bank vegetation. Alternatively, if bank sediment bound by a root network resists erosion, flow may undercut banks below the roots.

The above Figure illustrates the occurrences of bank erosion along an idealized river network. The bank erosion process in several sections of the river network is influenced by the size of the channel, discharge, and flow strength. So, bank erosion is an ongoing natural process. Even at rivers that are assumed to be stable, their well defined channels shift over a long period of time through the processes of erosion and sedimentation.

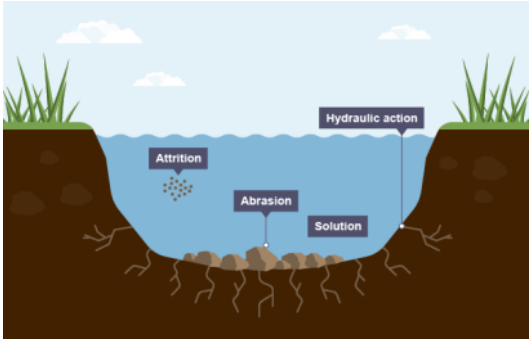
Erosion in rivers is caused by four processes; attrition, hydraulic action, abrasion (also called corrosion) and corrosion.

- Attrition happens when particles in the bank rub against each other.
- Hydraulic action erodes with the force of the water.
- Abrasion is when the river's load scrapes against the bank and bed, rubbing off small particles.
- Corrosion is caused by acidic water which breaks down rock and soil.

Hydraulic action is the erosion that occurs when the motion of water against a rock surface produces mechanical weathering. Most generally, it is the ability of moving water (flowing or waves) to dislodge and transport rock particles. Within this rubric are a number of specific erosion processes, including abrasion, attrition, corrosion, salutation, and scouring (down cutting). Hydraulic action is distinguished from other types of water facilitated erosion, such as static erosion where water leaches salts and floats off organic material from unconsolidated sediments, and from chemical erosion more often called chemical weathering. It is a mechanical process, in which the moving water current flows against the banks and bed of a river, thereby removing rock particles.

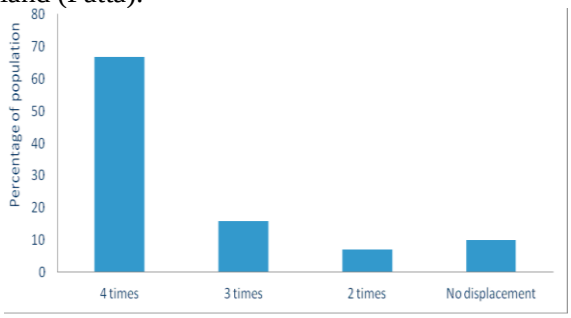
Impact of Ganges river bank erosion

Another study area was the Shantipur Block in the Nadia District of West Bengal. This place is more than 211 km downstream of Farakka Barrage, and is situated at the left bank of the river Bhagirathi-Hooghly (one branch of River Ganges). The river here resorts to massive bank erosion. The socio-economic impact of bank erosion in some villages of this Block has been assessed in a study by Chatterjee and Mistri



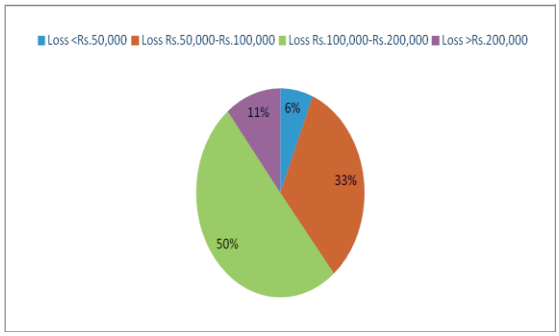
(2013). Once, Methiadanga was a village in this block that had been gradually engulfed by the river. People residing there continuously shifted inward as the river was consuming the village. Population in this village shifted several times in

nearly 20 years till the date of survey. Finally, when the village was almost eroded, they were relocated about 2 km east of the river. State government provided displaced villagers free land (Patta).



Frequency of displacement of population in Methidanga village. (Source: Chatterjee and Mistri, 2013)

The displaced people lost their houses, industrial set-ups (handlooms), multiple-crop lands and cattle. Their losses were estimated in monetary terms. The range of their losses was 50 000 – 200 000 Indian rupees. Even the loss of a few people exceeded 200 000 Indian rupees. This loss, mainly multiple-crop-land, made them (who were previously farmers) unemployed, and they were bound to do informal jobs like rickshaw-pulling or weaving. Handloom is a cottage industry in Shantipur Block and this industry is famous for "Shantipur Tant (cotton) Saree". Some of the displaced people in this village were weavers. Due to river bank erosion previous production set-ups were lost, and they had to rebuild their handlooms in new settlements. But this process could not be continued since displacement occurred more than one time. In the long run, their capitals were eroded gradually as they had to shift several times. Some of these distressed people even migrated to Mumbai and Delhi to work as assistants to the jewelers. However, this study is lacking some important analysis, like loss in income and reduction in essential expenditures, to identify their distress. Their deterioration in health and educational status due to forcible displacement was not evaluated, which would be highly required for such studies. Also, social security of the displaced people needs to be assessed.



Percentage of population suffering loss. (Source: Chatterjee and Mistri, 2013)

The Ganges bank erosion in other districts of West Bengal is less important compared to the Malda and Murshidabad districts. Until now, more than 700 000 people in these two districts have been displaced due to Ganges bank erosion (Mukherjee, 2008). There is a general tendency of River Ganges to shift towards the left bank above Farakka Barrage (Malda district), and towards the right bank below Farakka Barrage (Murshidabad and other districts). The river has so far eroded 356 km^2 of fertile land from the district of Murshidabad (Rudra, 2005). It has been reported that nearly 80 000 people in this district were displaced only during 1988 – 1994 (Rudra, 2005). Land loss due to erosion in Malda is worse, too. More than 200 km^2 of fertile land in Malda district have been completely wiped out until 2004.

Techniques for River Bank Stabilization:-

There could be two broad ways of stabilizing banks – firstly the direct methods of protecting the slope, and secondly the indirect way by providing structures that extend into the stream channels and redirect the flow so that hydraulic forces at the channel boundary are reduced to a non - erosive level.

Amongst the direct methods available for bank stabilization, the following broad categories are as follows:-

- Self-adjusting armour made of stone or other materials
- Rigid armour
- Flexible mattress

The advantages of this type protection are that armoring the surface of the bank is a proven approach which can be precisely designed for a given situation, and which provides immediate and effective protection against erosion. Also, existing or potential problems from erosion by overbank drainage can be effectively addressed integrally with the design of the stream bank armour work. Disadvantages for these types of bank protection include preparation of the bank slope is usually required, either for geotechnical stability or to provide a smooth surface for proper placement of the armour. This may result in high cost, environmental damage, and disturbance to adjacent structures. The extent of earthwork associated with an armour revetment will be especially significant if the existing channel alignment is to be modified either by excavation or by placing fill material in the channel. The following sections describe the three types of bank protection works.

As for the indirect methods for bank stabilization, these may be classified into the following categories.

- Dikes - Permeable or Impermeable
- Retards - Permeable or Impermeable
- Other flow deflectors like Bend way weirs, Iowa vanes, etc.

The advantages of this type of protection are that little or no bank preparation is involved. This reduces costs of local environmental impacts, and simplifies land acquisition. However, the main disadvantage is that these are not very effective where geotechnical bank instability or erosion from overbank drainage are the main causes of bank erosion. Further the construction of these is not very effective where geotechnical bank instability or erosion from overbank drainage is the main causes of bank erosion. Further, the construction of these structures induce significant changes in flow alignment, channel geometry, roughness and other hydraulic factors, which have to be carefully checked to find out any adverse implication of the river's geomorphology. Some types of indirect protection may also pose safety hazard if the stream is used for recreation or navigation. Lastly, since indirect methods require structures to be constructed deep into the stream channel, their construction may become practically difficult, especially during high flows.

CONCLUSION

- It is clear from the above discussion that the overall scenario of river bank erosions and their impacts are very depressing. As a result of riverbank erosion and their displacement, forced migrants are at the risk of insecurities in different form. The uncertainties that they face are economic insecurity due to unemployment, erosion of capital and indebtedness, social insecurity due to deprivation of civic rights, health insecurity due to lack of basic infrastructure, etc. All these insecurities caused by forced migration lead to deprivation, destitute, fragility and more vulnerability of the families.
- Riverbank erosion thus has negative impact on human life. Conversely, human activities also have impact on riverbank erosion. The poverty of the Malawians has created pressure on catchment areas or rivers. People cultivate on riverbanks because of its fertile land. No fertilizers are needed. River banks provide better yields than upland farms that are depleted of nutrients. Because of these benefits, there is over-cultivation, poor management of cultivated fields, and indiscriminate cutting down of trees. All this leads to riverbank erosion along with river sedimentation, water pollution and fish habitat alteration.

Application Of GPS & GIS

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1. INTRODUCTION:

A. *GPS*

The Global Positioning System (GPS) is a satellite-based navigation and surveying system for determination of precise position and time, using radio signals from the satellites, in real-time or in post-processing mode. GPS is being used all over the world for numerous navigational and positioning applications, including navigation on land, in air and on sea, determining the precise coordinates of important geographical features as an essential input to mapping and Geographical Information System (GIS), along with its use for precise cadastral surveys, vehicle guidance in cities and on highways using GPS-GIS integrated systems, earthquake and landslide monitoring, etc. In India also, GPS is being used for numerous applications in diverse fields like aircraft and ship navigation, surveying, geodetic control networks, crustal deformation studies, cadastral surveys, creation of GIS databases, time service, etc., by various organizations.

B. *GIS*

Geographic information system is a science of understanding the world by explaining human interaction with the Earth including analysis, modeling and prediction of future aspect in aiding decision making for proper management (Poku and Arditi 2006; and Huxhold 1991).

2. SYSTEM DESCRIPTION IN GPS:

A. General

The NAVSTAR Global Positioning System is a satellite-based navigation system being developed and maintained by the DOD since 1972, for providing extremely accurate 3-D position fixes and UTC information to properly equipped users anywhere on or near the Earth, at any time, regardless of weather conditions. Uncertainties in positions of GPS satellite and timing signals, imposed due to security reasons by DOD, and other error sources, are expected to limit accuracy of determination of absolute position of observation station in real time mode to few

meters, with few minutes of observations; however, various modes of observations and data analysis available and being developed, would yield accuracies better than few mm. in relative positions for base lines up to 2000 km, with few hours of observations, at minimum cost.

Historical Background –

The TRANSIT NNSS - the satellite navigation system operational prior to GPS, was launched in 1958 by the U.S. Navy. It became operational in 1964 and was made available to civilian users in 1967. The system, comprising 5 satellites at 1075 km altitude, was phased out in the early 90s. This system has now been replaced by the NAVSTAR GPS in an extensive multibillion

dollars project launched in 1972 as a Joint Services Program of U.S. Air Force, Navy, Army, Marines and Defense Mapping Agency; in three phases. The GPS system became fully operational and available to the commercial users by early 90s.

A. ***GPS Segments*** –

1. Space Segment
2. Control Segment
3. User Segment

B. ***Features of GPS Satellites***

C. ***Principle of Operation***

D. ***Present Status***

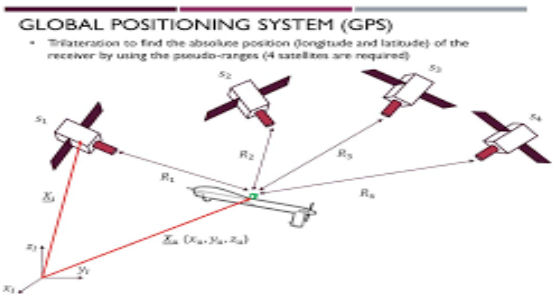
E. ***Accuracies with GPS and Comparison with other Techniques***

3 SURVEYING WITH GPS:

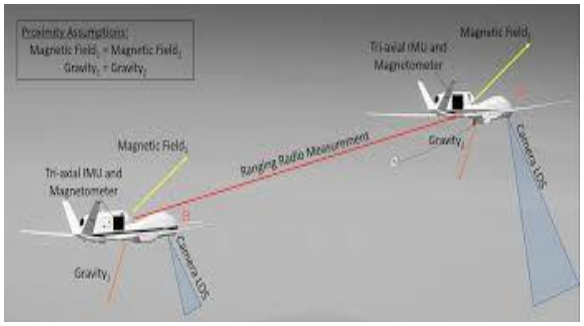
Within the span of few years of its operation, GPS has truly revolutionized the field of surveying, with its potential to replace many conventional surveying techniques in use today. The different methods of surveying with GPS will be briefly described here, along with a review of GPS instrumentation and method of computation of geodetic and map coordinates from the GPS observations.

A. Methods of Observations

The different methods of observations with GPS include, absolute positioning, relative positioning in translocation mode, relative positioning using differential GPS technique, and kinematic GPS surveying technique.

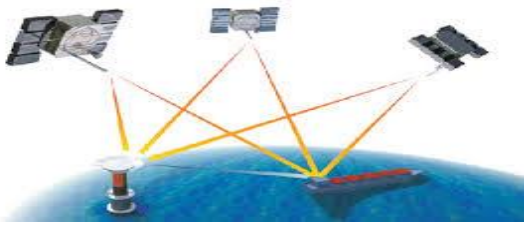


1 Absolute Positioning:



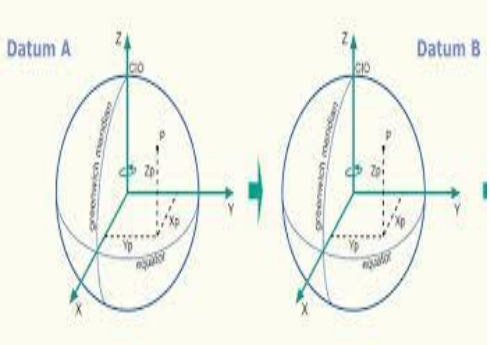
2 Relative Positioning:

3 Differential GPS:



B. Computation of co-ordinates

From GPS observations, it is possible to obtain the Cartesian rectangular coordinates: X, Y, Z, in an ECEF global reference system. Often, the users require the coordinates of points in some local reference system - either geodetic latitude, longitude and height, or grid coordinates. Hence, transformation of coordinates from the global system to the local system is necessary.

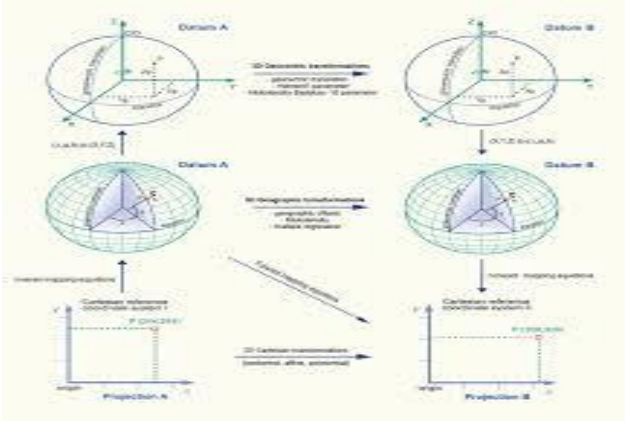


1. Transformation from Global to Local Datum

The GPS coordinates are in the global World Geodetic System, 1984 (WGS84) developed by the Defense Mapping Agency (DMA) of U.S.A. These need to be transformed to the local datum in use in the particular country, e.g. Everest Ellipsoid in India. The transformation of coordinates involves seven transformation parameters - the three translations due to shift of origin, three rotations due to change in orientation (which are theoretically zero due to the axesbeing parallel) and a scale factor due to the different dimensions of the two reference ellipsoids. These transformation parameters must be estimated, using coordinates of several well distributed stations in both the systems, in order to obtain the geodetic coordinates in local reference system. The values of these parameters, as evaluated by DMA for several local geodetic datums in the world, are given in Table 7 of [DMA, 1987], which need to be refined by rigorous computations and using additional data, in order to achieve a high level of accuracy in coordinates.

2. Geodetic Coordinates to Map Coordinates

The conversion from geodetic coordinates (latitude, longitude and height) to the grid coordinates on Indian topographical gridded maps (easting, northing and height) is described in [Thompson and Bomford, 1930]. It involves the transformation from the local geodetic system to the grid system superimposed on the map projection. The map projection used for Survey of India topographical maps is the Lambert conformal polyconic projection with two standard parallels, and the rectangular grid system is the Lambert Grid for India. Standard computerprograms are available for this transformation.



3. GPS Heights and Mean Sea Level Heights

The height deduced from GPS observations is the ellipsoidal height - height of the observation point above the reference ellipsoid. The geodetic

height of a point is the geoidal height - height above the geoid, commonly termed as Mean Sea Level (MSL) height. These two are related by the simple equation:

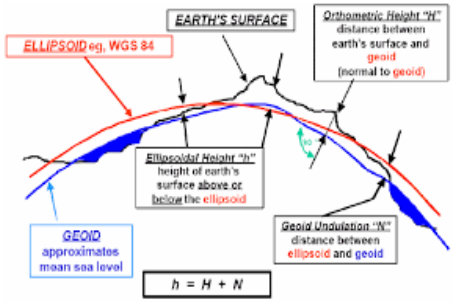
MSL Height (h) = Ellipsoidal Height (H) + Geoidal Undulation (N)

The geoidal undulation (geoid - ellipsoid separation) is derived from astro-geodetic or gravimetric data, the accuracy of which is limited to few cm. World Gravity Models are available for computing the value of N at the observation station. Thus, the MSL heights computed from GPS data will contain the error in the value of N, limiting its accuracy. However, in differential GPS levelling, due to cancellation of a large part of this error, the relative heights can be determined to a much higher accuracy. The estimated precision of determination of heights using GPS is about 1.5 times the precision of horizontal component.

APPLICATIONS OF GPS

Due to the high accuracy, versatility, ease and economy of operation, and all-weather operation offered by GPS, it has found numerous applications in many fields, ranging from the mm-level high precision geodesy to the several-meter level navigational positioning. Some of these applications are:

- Establishment of high precision zero order Geodetic National Survey Control Network of GPS stations.
- Strengthening, densification and readjustment of existing Primary Control



Networks using GPS station.

APPLICATIONS OF GIS

1. *GIS APPLICATION IN CONSTRUCTION MANAGEMENT*

GIS is widely used in Survey engineering project such as soil investigation, construction site management, earth excavation, sub-structure, superstructure construction progress and monitoring, resources management, labor and equipment monitoring and tracking, construction safety management and monitoring of underground tunnel, pipe line, and sewage system construction etc. Oloufa et al. (1994) were used GIS for making database of soil properties for the boreholes of corresponding locations. An automatic site layout system to select suitable location for temporary structure (Cheng and O'Connor 1996) and material storage were developed (Cheng and Yang's 2001) by using GIS. In addition, GIS was used for automatic schedule monitoring system for pre-cast construction developed by Heng and Chen (2000). GIS also used in highway construction for easy access of project personnel to the site (Udo-Inyang and Uzoije 1997) and for optimizing the road network planning to control the snow and ice effected route in Indiana Department, USA (Wright et al. 1993). Cheng et al. (2001) developed computed aided safety system in geotechnical construction with the help of GIS. Li et al. (2003) was applied GIS concept for online construction material procurement system and Li et al. (1996) also used GIS for tracking compaction process of pavement construction.

2. *GIS BASED CONSTRUCTION PROJECT INFORMATION SYSTEM*

GIS is a computer system for capturing, storing, quarrying, analyzing, and displaying geographic data. GIS is a special class of information system, which can be divided into four components involving a computer system, GIS software, human expert, and the data (Bansaland Pal, 2006). GIS activity can be grouped into spatial data input, attribute data management, data display, data exploration, data analysis, and GIS modeling mentioned byClark (2001). GIS can handle both spatial and attribute data, spatial

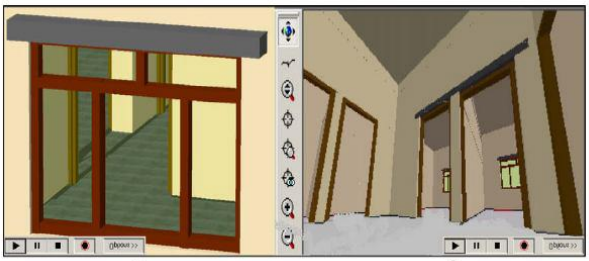
data relate to the geometry of the features, while attribute data describes the characteristics of the different features and stored in the tabular form. Each row of the table represents a feature while column represents the characteristic of features. The intersection of a column and a row show the value of particular characteristics of a feature. In the geo-relational data model, split data system is used to store spatial and attribute data in separate files and linked together by thefeature Identification Descriptor (ID). These two sets of data files are synchronized so that both can be quarried, analyzed, and displayed (Chang 2002).

3. Progress Monitoring and Control of Project

Before starting of construction, schedule of its different activities is prepared for achieving the target deadline of the project which is very helpful also for monitoring. It can be achieved easily with user friendly Bar chart technique developed by planner for scheduling. This bar chart can be formed by using ArcGIS guided by the activities attribute tables. In such case the activities are listed in order of construction priorities on the left-hand side column, while the time scale is plotted horizontally on the bottom commented by Bansal and Pal (2006). All the cases Arc View GIS is being used for both tabular and graphical presentation. The main advantage of the Arc View's chart document over conventional bar chart is that when a bar on bar chart in Arc View is clicked, a window appears which provide the information related to that particular activity of a project.

4. CONSTRUCTION SCHEDULE REVIEW BY GIS

Although integrate virtual planning was developed (Waly and Thablet, 2002) for planning the construction activities before going to real construction stages, GIS was used by Bansal and Pal (2008) for developing 3D-view of a project as well as CPM-based schedule of activities for monitoring real construction progress with its schedule which was not possible by the project management software like as primavera. Besides, their study created a dynamic relationship between schedule and corresponding 3D components which ensure problem detection in incompleteness or logical



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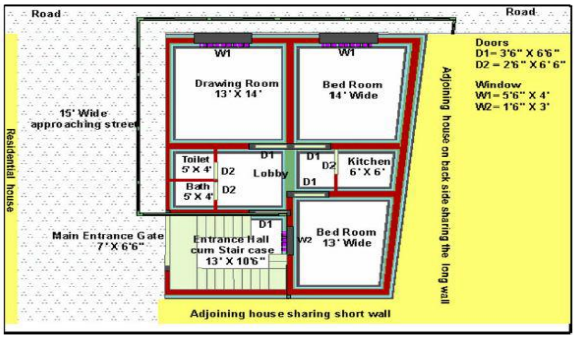


errors in work sequences. In this GIS based study, developed such a facility that can manage construction projects of their spatial and nonspatial data in a single platform which can only possible by introducing GIS application.

Floor Plan Consist of Different Data Layer in Arc GIS

5. GIS BASED COST ESTIMATION

Cost estimation is very much essential part of construction management which require in whole life of the project from feasibility study to the end of the construction period. The success of the project fully depends on the accuracy and proper management of the project cost. GIS became helpful software to estimate the cost of a project by selecting cost effective place for material storage at construction site, such a study was done by Cheng and Yeng (2001). They used the basic concepts of GIS like spatial and attribute features to select the suitable location regarding cost for example, how much material can be stored in a parcel of location for what cost were the matter of facts in this regard. Not only that, suitable location for material storage also influence the labor productivity and

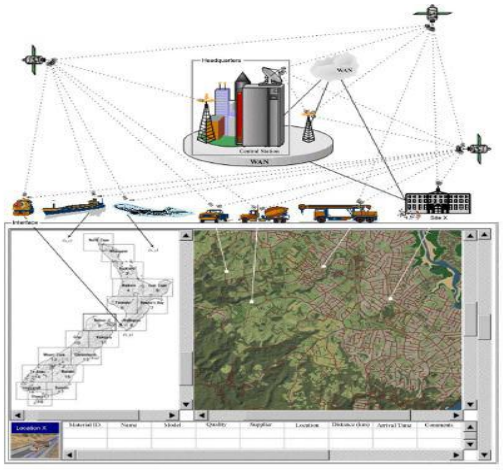
hence minimize the cost of the project. Besides, Cheng and Yang (2001) developed proximity index for optimal site selection to manage cost effective space for the material storage and for this purpose they introduced Material Plan tool in GIS which facilitates the construction planning and schedule design. This study changed the manual process of cost estimating to automatic computer aided process by taking quantity of material using GIS and developed dynamic material
requirements plan (DMRP) which means requirements of material with respect to construction schedule progress by this way they merged quantity takeoff with schedule plan.

6. *GIS FOR UNDERGROUND UTILITY ROUTE DESIGN AND PLANNING*

It is a big challenge for engineer to find out appropriate route for minimizing construction cost and avoiding constraints in trench construction. Cheng and Chang (2001) developed GIS based automatic route selection process and facilitated utility construction. They used network analysis for optimal paths determination to select best route. Since so many existing utilities such as water supply, gas distributing, telephone, sewerage etc. are constructed in underground routes further facility construction like electric supply always create problems
and damage the existing structure eventually delay the construction work. This situation creates basically, for the lack of spatial information as well as superimposing different layers manually to solve the conflicting points which is very difficult (Cheng and Chang 2001).However, GIS can provide spatial and attributes features of the locations and so many layers can be solved by GIS.

7. *GPS AND GIS FOR INCREASING CONSTRUCTION PRODUCTIVITY*

Integrated application of Global Position System (GPS) and GIS was proved as efficient automatic system for material and equipment management at construction site for reducing waste and thus increasing construction productivity by facilitating management system (Li etal. 2005). For this system, bar coding is used for tracking the equipment and vehicle enter into the site for transporting material. Following figure shows the material and equipment information system at construction



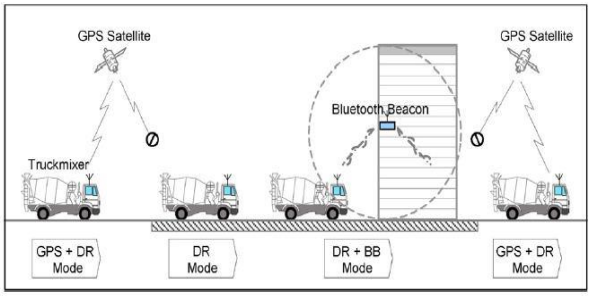
site.

Chen et al. (2002) developed Incentive Reward Program model for the crew by using barcode monitoring system for worker at site to reduce waste by them and giving reward for this work. However, this crew IRP was developed by worker motivation theory of Maslow et al. (1998).

8. *GPS IN POSITIONING AND TRACKING CONSTRUCTION VEHICLES*

At densely populated and heavy loaded traffic conditions with other constraints like neighbor buildings and adjacent road way make serious difficulties for supplying and placing ready mix concrete by maintain its quality. Plant management need to know the travel time, vehicles productivity to concrete deliver regarding site constraints and respective urban area attributes. For concrete plant operation, concrete placing productivity is very much important. Lu et al. (2003) provided a simulation result for planning concrete production at plant and later on, quantitative analysis for concrete placing rates with its quality control was first done by Lu and Anson (2004) for facilitating the batch plant management. Anyway, arrival of concrete at right place at just time while maintaining its quality is very much important (Akintoye, 1995) that is why tracking and monitoring concrete transport vehicle obviously important task for the planner. Although GPS can collect data automatically, it has some drawback regarding accuracy at place of highly

dense structured (Lu et al. 2007) area as well as tracking moving vehicle at heavy traffic loaded



roadway (Mattos, 2003). This limitation little bit solved by GPS with wireless communication for tracking vehicle in open space developed an integrated process of GPS, Dead Reckoning (DR), and Bluetooth Beacon for tracking and positioning construction vehicle with respect to time.

Mivan Constrution Technolgy

By – Md. Irfan Alam
(Lecturer Civil Engineering Department)

Abstract

The aluminum formwork system was developed by Malaysian Company and that's why the aluminum formwork technology is named after it. Mivan is new construction technology upcoming for successful completion of mass housing project in India. In this project we have discussed about cost comparison of mivan technology with conventional construction technology. The Mivan technology is absolutely fine with cost, quality and time saving as compare to conventional. In this project we have taken a review from the people who are occupying the houses constructed by mivan technology to get the feedback from occupant on mivan technology. The project also include remedial measure for one of the defect in mivan technology i.e. segregation while placing the concrete resulting honeycombing in shear walls by using "Master Glenium ACE 30JP" admixture.

***Index Terms*— cost comparison, user review, Master Glenium ACE 30JP" admixture.**

***Keywords*— Mivan,Components,Wall panel, Kicker, Rocker,**

Prop length, Internal corner, Beam-bar, Deck panel, Soffit length.

INTRODUCTION

The Mivan Technlogy System was developed by Mivan Company Ltd from Malaysia late 1990s as a system for constructing mass housing project in developing countries. The units were to be of cast-in-place concrete, with load bearing walls using a formwork of aluminum panels. To be erected by the hundreds, of a repetitive design, the system ensured a fast and economical method of construction. The concrete surface finish produced with the aluminum forms allows achievement of a high quality wall finish without the need for extensive plastering. This is one of the systems identified to be very much suitable for Indian conditions for mass construction, where quality and speed can be achieved at high level. The speed of construction by this system will surpass speed of most of the other construction methods/technologies

MIVAN Formwork

A. Requirement of Mivan Formwork

The Mivan formwork is made up of of an aluminum alloy. While Construction is in process , the formwork is supposed to bear, besides its own weight, the weight of wet concrete, the live load due to labor, and the impact due to pouring concrete and workmen on it. The vibration caused due to vibrators used to compact the concrete should also be taken care off. Thus, the design of the formwork considering its requirements is an essential part during the construction of the building. The Mivan Formwork should be able to take a live load including the impact about 370kg/m². It is however, usual to work with a small factor of safety in the design of formwork. The surfaces of formwork should be dressed in layout. Such a manner that after deflection due to weight of concrete and reinforcement, the surface remains horizontal, or as desired by the designer. The sheathing with full live load of 370 kg/m² should not deflect more than 0.25 cm and the joists with 200kg/m² of live load should not deflect more than 0.25cm.Maintaining the Integrity of the specifications. The modular nature of the

mivan formwork should allow easy fixing and removal of formwork and the construction can proceed speedily with very little deviation in dimensional tolerances. Further, it should is quite flexible and can be easily adapted for any variations in the layout.

B. Genenral specification of Mivan Formwork

The basic element of the Mivan Formwork is the panel, which is an extruded aluminum rail section, welded to an aluminum sheet. This produces a lightweight panel with an excellent stiffness to weight ratio, yielding minimal deflection under concrete loading. Panels are manufactured in the size and shape to suit the requirements of specific projects. The panels are made from high strength aluminium alloy with a 4 mm thick skin plate and 6mm thick ribbing behind to stiffen the panels. Earlier the panels were used to manufacture only in factories in Europe and South East Asia but in recent the formwork componamts are started manufacturing in india as well e.g. COSMOS Construction Machineries And Equipments Pvt. Ltd . Once they are assembled they are subjected to a trial erection in order to eliminate any dimensional or on site problems. The formwork components are durable they can be used repetitively up to 200 times. It is light weighted so heavy lifting is eliminated, the heaviest components is of 25 kg, a labor can easily lift it

C. Uses of Mivan Formwork

- System of Construction-Speed, Strength, Safety.
- Column and beam construction are eliminated.
- Walls and slabs are cast in one operation.
- Specially designed, easy to handle light weight pre-engineered aluminum forms.
- Fitting and erecting the portion of shuttering.
- Carrying out concreting of the walls and slabs together.

D. Advantages of Mivan formwork over Conventional construction

- More seismic resistance: The box type construction provides more seismic resistance to the structure.
- Increased durability: The durability of a complete concrete structure is more than conventional brick bat masonry.
- Lesser number of joints thereby reducing the leakages and enhancing the durability.
- Higher carpet area-Due to shear walls the walls are thin thus increasing area.
- Integral and smooth finishing of wall and slab-Smooth finish of aluminum can be seen vividly on walls because of small sizes Enisitations Of Misemon the concrete surfaces.
- Concealed services become difficult due to small thickness of components.
- It requires uniform planning as well as uniform elevations to be cost effective.
- Modifications are not possible as all members are caste in RCC.
- The formwork requires number of spacer, wall ties etc. which are create problems such as seepage, leakages during monsoon.
- Negligible maintenance -Strong built up of concrete needs no maintenance.
- Faster completion-Unsurpassed construction speed can be achieved due to light weight of forms.
- Lesser manual labour- Less labour is required for carrying formworks.
- Simplified foundation design due to consistent load distribution.
- The natural density of concrete wall result in better sound transmission coefficient.

E. <u>Mivan Components</u>

1. WALL PANEL

The Wall Panel forms the face of the wall from the top of the Rocker to the underside of the Top Panel.

2. KICKER

The kicker forms the wall Face at the top of the Top Panels. It is anchored to the concrete and acts as a ledge for the Wall panels on the next floor to sit on

3. *INTERNAL CORNER*

The Internal Comer connects 2 pieces of vertical formwork together of their internal intersection.

4. PROP LENGTH

The prop length is manufactured to a specific length for each project. It transmits load to the previous slab.

5. BEAM-BAR

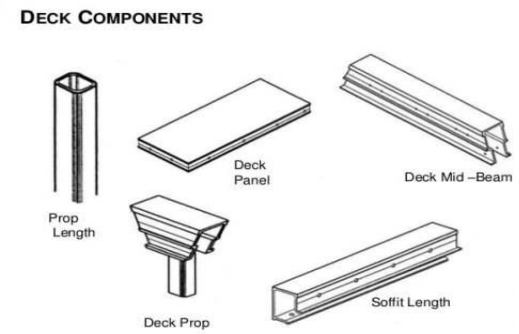
These are used in pairs to fix the Mid Beam and End Beams to the deck prop. The beam_Bar is removed when the slab is cast to allow quick striking of the deck form work.

6. ROCKER

Rocker is an L-shaped panel having allotment holes for stub pin to support the wall panels

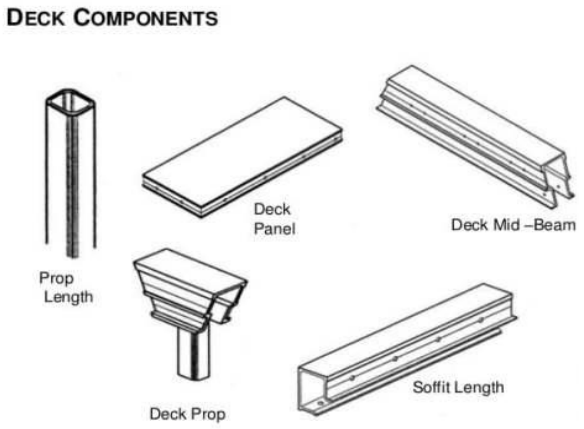
7. Prop Head and Panel for Soffit Bea:

In the beams, where there is no support from the bottom, prop heads are used to support the beam. It has a V-shaped head for easy dislodging of the formwork. Soffit beam panel is a rectangular aluminum structure placed in the prop head to support the soffit beams



8. Deck Components

A.Deck Panels
A horizontal flat surface upon which the slab is cast.



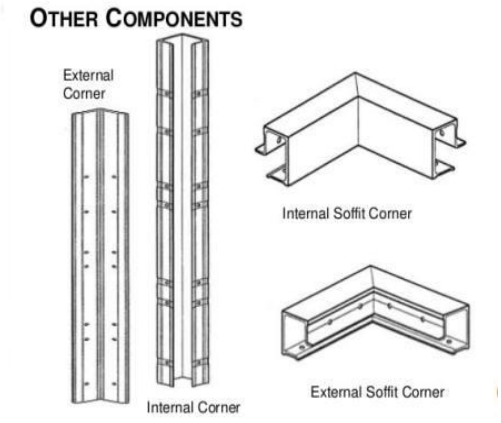
B.Deck Prop and Prop Length
Deck prop is the same as that of beam deck prop, here it is used to support the slab and bears the load coming on the deck panel.
Prop lengths are the vertical support to the deck prop which are adjustable as per the slab height.

C.Soffit Length

Soffit length provides support to the edge of the deck panels at their perimeter of the room.

9. Other Components

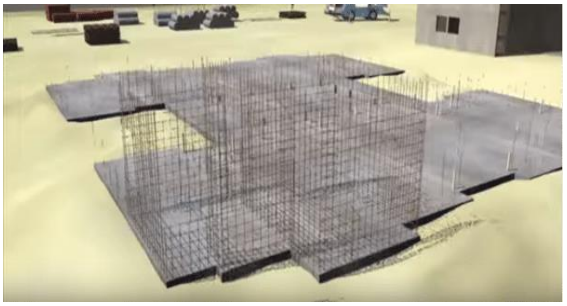
The other components used excluding wall, beam and deck components are internal and external soffit corners, exterior and interior corners for wall panels.



F. Mivan Formwork Erection Process

1. *Placement of Aluminum Formwork*

- Mivan formwork is majorly used in the places where the whole structures made of concrete.
- All formwork is cleaned and coated with an approved realize agents.
- The wall reinforcing steel is placed with the floor slab.
- Along with the wall reinforcing steel, prefabricated room-sized walls panels and floor slabs panels are erected.
- Plumb, level, and dimensions are checked.
- The aluminum alloy slabs are accurately made as per the required sizes.
- Spaces for windows, ducts, doors and other features such as staircases, façade panels, and chajjas are also integrated into these structures.
- The forms are then joined together using the pin and wedge system, which can be dismantled quickly after the concrete structure is made.



2. *Pouring of Concrete*

- After casting the forms, high-quality concrete is poured.
- This concrete takes the form and shape of the cast.
- At least two operatives should be on standby during concreting for checking pins, wedges and wall ties as the pour is in progress.
- Special attention to be given while pouring concrete for dislodging of pins/wedges, slipping of props or overspill of concrete at openings

3. *Striking of Formwork*

- Normally all formwork can be struck after 12 hours of concreting.
- First, the wall formwork is strike down, followed by deck formwork.
- The removed formwork is cleaned with scrapers and wire brushes as soon as they are struck.
- Once cleaned, it is transported and stacked properly for the next use.

G. Features of Mivan Formwork

The major features of Mivan formwork are given below –

1. *Load Carrying Capacity*

The load-carrying capacity of Mivan formwork is 7-8 Tonnes per square meter. Mivan formwork is lightweight and weighs around 18-20 kg per meter square.

2. *Striking Time*

The striking time of vertical (wall) formwork is 12 hours after concreting or when concrete strength has reached 2N/mm2 and horizontal (deck) formwork is 36 hours after concreting or when concrete strength has reached 10N/mm2.

3. Durability

As the panels of Mivan formwork are made of structural grade aluminum alloy, they are very durable and sturdy. A single component can be repeated around 200 times.

4. *Cycle Time*

High speed of construction can be achieved by this system that means faster completion of the project. Approximately, the times required to cast floor is 7 days with the use of Mivan formwork

H. Advantages of Mivan Formwork

- High-quality formwork ensures consistency of dimensions.
- On removal of the mold, a high-quality concrete finish is produced to accurate tolerances and verticality.
- The total system forms the complete concrete structures.
- Custom designed to suit project requirements.
- Unsurpassed construction speed.
- Panels can be reused up to 250 time
- It can be erected using unskilled labor.

I. . Disadvantages of Mivan Formwork

- The concealed services become difficult due to the small thickness of components.
- It requires uniform planning as well as uniform elevations to be cost-effective.
- Modifications are not possible as all members are caste in RCC.
- The large volume of work is necessary to be cost-effective i.e. at least 200 repetitions of the forms should be possible at work.
- The formwork requires a number of the spacer, wall ties, etc. which are placed @ 2 feet c/c; these create problems such as seepage, leakages during monsoon.
- Due to box-type construction shrinkage cracks are likely to appear.
- The heat of hydration is high due to shear walls.

COST COMPARISON

By adopting Mivan technology in the project not only it gives the better quality of construction and but also increases the speed of construction and reduces the cost since some of the construction activities are completely eliminated and others are reduced to a extent . This project includes the cost comparison of conventional construction with Mivan Technology of construction. The following comparison is from the data acquired at Paranjpe schemes's "Blue Ridge" a 138 acre integrated township Hinjewadi , Pune.

CONCLUSION

The task of housing due to the rising population of the country is becoming increasingly monumental. In terms of technical capabilities to face this challenge, the potential is enormous; it only needs to be judiciously exploited by innovative construction methods. Traditionally, construction firms all over the world have been refraining to adopt the innovation and changes. It is the need of time to analyze the depth of the problem and find effective solutions. mivan serves as a cost effective and efficient tool to solve the problems of the mega housing project all over the world. MIVAN aims to maximize the use of modern construction techniques and equipments on its entire project.

We have tried to cover new aspects related to mivan technology viz. cost comparison based on case study, feedback from the people and remedial measure to solve the one of the major defect in mivan technology. We thus infer that mivan technology is able to provide high quality construction at unbelievable speed and at reasonable cost. This technology has great potential for application in India to provide affordable housing to its rising population.

Thus it can be concluded that quality and speed must be given due consideration with regards to economy. Good quality construction will never deter to projects speed nor will it be uneconomical. In fact time consuming repairs and modification due to poor quality work generally delay the job and cause additional financial impact on the project. Some experts feel that housing alternatives with low maintenance requirements may be preferred even if at the slightly may preferred even if at the higher initial cost.

From the survey and cost comparison we can come to the conclusion that mivan technology is win-win situation for the builder who is going to construct and consumer who is going to occupied the house. Hence mivan technology is the need of time to solve the problems of mega housing projects in India.

FUTURE SCOPE

This thesis work is restricted to some aspects of Mivan technology . The future researchers can continue by working over the aspects of mivan construction such as Climatic effect on structure as whole structure is constructed in concrete only and Modernization in electrification work in mivan formwork. Furthermore interviews of different people from construction industry can be taken based on questionnaire prepared and analysis can be done.

ACKNOWLEDGEMENT

In regards we are extremely fortunate in having Asst. Prof. Mahesh V. Tatikonda (Department Of Civil Engineering) as our project guide. It had been not possible without his incredible help coupled with valuable suggestions, relentless effort and constructive ideas, more over his optimistic attitude, guidance and understanding making us believes all that accomplished was our effort for which we will ever remain indebted to him.. We would like to express our gratitude to Prof. Smita V. Pataskar, H.O.D. of the Department Of Civil Engineering for her escorting role in meeting our objectives. At this moment, we cannot forget to pay sincere regards to our Parents who are a big source of inspiration and blessings.

Groundwater Recharge: Its Importance and Socio-Environmental Value

By
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Groundwater is one of the most important and vital natural resources which is stored in the subsurface geological formations in the critical zone of the earth's crust. It serves as a source of water for domestic, industrial and agricultural uses and other developmental initiatives. The ever-increasing demand of water for meeting human requirements and developments has imposed immense pressure on this limited freshwater resource. The occurrence and distribution of groundwater depends on the various natural and anthropogenic factors. The groundwater related problems are severe in most parts of the tropical and subtropical regions that have high population density and economic developments. In a semi-arid country like India, surface water is not available round the year for meeting different purposes and hence people in such areas have to depend more on groundwater resources for their survival. Millions of people in India are facing high to extremely high water stress due to inadequate availability of fresh water. Further, about three-fourth of the households in the country do not have access to portable water at their premises. According to a World Bank report, if adequate measures are not taken, India will become a water stress zone by the year 2025 and a water scarce zone by the year 2050. All these reiterate the need for better understanding of all the available fresh water resources of the country with special reference to groundwater resource, as it constitutes a major share of India's freshwater resources.

The population and industrial growth is increasing rapidly day by day since for the last two decades and the enormous demand of water creates a periodic water-stressed condition especially for the arid and semi-arid region due to the worse seasonal precipitation pattern and scarcity of the surface water. Especially for these regions, the management of useable water resources is so much required to fulfill the potable water demand and groundwater is the perfect choice to meet the demand.

At present nearly one-fifth of all over the water used in the world is obtained from groundwater resources. With the increasing use of groundwater for agriculture, municipal and industrial needs, the annual extractions of groundwater are far in excess of net average recharge from natural resources. Consequently, groundwater is being withdrawn from storage and water levels are declining, resulting in crop failures, sea water intrusion in coastal aquifers and land subsidence in areas where drafts result in compaction of sediments.

In USA, Australia, Europe everywhere it is now the most critical concern for the scientists and water resources engineers. In India also it is in a stage where we must be aware that it is not so far when we will be out of cheap drinking water. According to 'World Resources Institute' about 54% of India faces high to extremely high water-stress.

For the excessive usage of groundwater, the natural recharge is not sufficient for optimum replenishment of groundwater and maintains the critical level. At this alarming situation, as a remedial measure, modern technologies can be used to delineate the groundwater storage zone and estimate the recharge.

Artificial recharge is a method of modifying the hydrological cycle and thereby providing groundwater in excess of that available by natural processes. It is accomplished by augmenting the natural infiltration of precipitation or surface water into underground formations by some method of construction, by ponding or spreading of water, or by artificially changing the natural conditions.

Under these circumstances, there is a need for scientific planning in the development of groundwater under different hydrogeological situations and to evolve effective management practices with involvement of community for better groundwater governance. In view of the emergent challenges in the groundwater sector in the country, there is an urgent need for comprehensive and realistic information pertaining to various aspects of groundwater resources available in different hydro-geological settings through a process of systematic data collection, compilation, data generation, analysis, and synthesis.

The traditional approaches used to identify, delineate and map the groundwater potential zones are mainly based on ground surveys using geophysical, geological and hydro geological tools which are generally expensive and time consuming. Geospatial tools, on the other hand, are rapid and cost-effective in producing and modeling valuable data in various geosciences fields. Remote sensing and GIS study with its advantages of spatial, spectral and temporal availability of data converging large and inaccessible areas within a short span of time has become a powerful tool in assessing, monitoring and conserving groundwater resources.

There are plenty of advantages of mapping and recharging groundwater potential zone and some of those are:

- Exploit the surplus surface water which otherwise drains off.
- Enhance the reliability of yield from pumping wells.
- Reduction of surface runoff which can eventually reduce the risk of urban flooding.
- Reduce the risk of inundation of large surface areas and loss of crops.
- Improvement of water quality due to the removal of harmful chemicals, suspended sediments, etc. in the filter layer.
- Large storage structures are not required to store water.
- No displacement of local people, unlike the other water resources projects.
- Reduction in the cost of energy for lifting water as the water table rises due to groundwater recharge.

Central Groundwater Board (CGWB) plays a vital role since few decades on replenishment of groundwater.

Upgradation Of Pavement By Using Fibre-Reinforced Concrete

By – Sk Soyep Ali
(Lecturer, Civil Engineering Department)

Road transportation is undoubtedly the lifeline of the nation and its development is a crucial concern. The traditional bituminous pavements and their needs for continuous maintenance and rehabilitation coupled with frequent repairs, points towards the scope for cement concrete pavements. There are several advantages of cement concrete pavements over bituminous pavements. This paper explains benefits of RECRON3S FIBRE REINFORCED CONCRETE PAVEMENTS, which is a recent advancement in the field of Reinforced Concrete Pavement design with a Case Study of NICE ROAD-Bangalore which is India's Longest White-topped Road using Recron3S Fibres is presented.

Introduction

In a developing country such as India, road networks form the arteries of the nation. A pavement is the layered structure on which vehicles travel. It serves two purposes, namely, to provide a comfortable and durable surface for vehicles, and to reduce stresses on underlying soils. In India, the traditional system of bituminous pavements is widely used. Locally available cement concrete is a better substitute to bitumen, which is the byproduct in distillation of imported petroleum crude. It is a known fact that petroleum and its by-products are dooming day by day. Whenever we think of a road construction in India it is taken for granted that it would be a bituminous pavement and there are very rare chances for thinking of an alternative like concrete pavements. Within two to three decades bituminous pavement would be a history and thus the need for an alternative is very essential. The perfect solution would be SYNTHETIC FIBRE REINFORCED CONCRETE PAVEMENTS, as it satisfies two much demanding requirement for pavement material in India, economy & less pollution. It also has several other advantages like longer life, low maintenance cost, fuel efficiency, good riding quality, increased load carrying capacity and impermeability to water over flexible pavements. Fibre Reinforced Concrete Pavements are more efficient than ordinary cement concrete pavement. "FRC is defined as composite material consisting of concrete reinforced with discrete randomly but uniformly dispersed short length fibres." The fibres may be of STEEL, SYNTHETIC or natural materials. FRC is a material of improved properties and not as reinforced cement concrete whereas reinforcement is provided for local strengthening of concrete in tension region. Fibres generally used in cement concrete pavements are Steel fibres and organic Synthetic Polymer fibres such as Polyester or Polypropylene.

Fibre Reinforced Concrete

Concrete is well known as a brittle material when subjected to normal stresses and impact loading, especially, with its tensile strength being just one tenth of its compressive strength. It is only common knowledge that, concrete members are reinforced with continuous reinforcing bars to withstand tensile stresses, to compensate for the lack of ductility and is also adopted to overcome high potential tensile stresses and shear stresses at critical location in a concrete member. Even though the addition of steel reinforcement significantly increases the strength of the concrete, the development of

micro cracks must be controlled to produce concrete with homogenous tensile properties. The introduction of fibres was brought into consideration, as a solution to develop concrete with enhanced flexural and tensile strength, which is a new form of binder that could combine Portland cement in bonding with cement matrices. Fibres are generally discontinuous, randomly distributed throughout the cement matrices. Referring to the American Concrete Institute (ACI) committee 544, in fibre reinforced concrete there are four categories namely

1. SFRC - Steel Fibre Reinforced Concrete
2. GFRC - Glass Fibre Reinforced Concrete
3. SNFRC- Synthetic Fibre Reinforced Concrete
4. NFRC - Natural Fibre Reinforced Concrete

Fibre Reinforced concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete with discontinuous, discrete, uniformly dispersed suitable fibres. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibres. Fibre reinforced concrete (FRC) is concrete containing fibrous material, which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres may generally be classified into two: organic and inorganic. Inorganic fibres include Steel fibres and Glass fibres, whereas organic fibres include natural fibres like coconut, sisal, wood, bamboo, jute, sugarcane, etc., and synthetic fibres based on Acrylic, Carbon, Polypropylene, Polyethylene, Nylon, Aramid, and Polyester. Within these different fibres the character of fibre reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation and densities.

Fibres are usually used in concrete to control cracking in its Plastic and Drying states. They also lower the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion and shatter resistance in concrete. The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibres) termed volume fraction (Vf). Vf typically ranges from 0.1 to 3%. Aspect ratio (l/d) is calculated by dividing fibre length (l) by its diameter (d). Fibres with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the modulus of elasticity of the fibre is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Fibres that are too long tend to "ball" in the mix and create workability problems.

Polymer Synthetic Fibre Reinforced Concrete (PSFRC)

Polymeric fibres are gaining popularity because of its properties like zero risk of corrosion and cost effectiveness. The polymeric fibres commonly used are Recron3s--Polyester and Polypropylene. These fibres act as crack arresters, restricting the development of cracks and thus transforming a brittle material into a strong composite with superior crack resistance, improved ductility and distinctive post cracking behavior prior to failure. Concrete pavements may be weak in tension and against impact, but PFRC is a suitable material, which may be used for cement concrete pavement as it possesses extra strength in flexural fatigue and impact etc. The usage of fibres in combination with concrete also results in a mix with improved early resistance to plastic shrinkage cracking and thereby protects the concrete from drying shrinkage cracks. It accomplishes improved durability and reduced surface water permeability of concrete. It reduces the risk of plastic settlement cracking over rebar. It enables easier and smoother finishing. It also helps to achieve reduced bleeding of water to surface during concrete placement, which inhibits the migration of cement and sand to the surface and the benefits of the above will be harder, more durable surface with better abrasion resistance. A uniform distribution of fibres throughout the concrete improves the homogeneity of the concrete matrix. It also facilitates reduced water absorption, greater impact resistance, enhanced flexural strength and tensile strength of concrete. The use of polymer fibres with concrete has been recognized by the Bureau of Indian Standards (BIS) and Indian Road Congress and is included in the following Standard documents:

- IS:456:2000 – Amendment No.7, 2007
- IRC:44-2008 – Cement Concrete Mix Designs for Pavements with fibres
- IRC:SP 46-2013—Guidelines for Design &

Construction of Fibre Reinforced Concrete Pavements.
- ICI-Indian Concrete Institute-Technical Committee recommendation for Fibre Reinforced Concrete-TC-01
- IRC: SP: 76:2008 – Guidelines for Ultra Thin White Topping with fibres
Polymer Fibre Reinforced Concrete has been approved by National Bodies

Like:
1. Central Public Works Department (CPWD) & Local State PWDs.

2. Airport Authority Of India

3. Military Engineering Services

4. Defense Airfield

5.Railway

India's Longest White-Topped Concrete Road Using Fibres

Project—Bangalore-Mysore Infrastructure Corridor Project (BMICP) – NECE Ltd.-Nandi Economic Corridor Enterprises Limited.
Salient Features of the Project
1. First White Topped Project in India – Completed in May 2013.
2. Longest White topped Concrete Road in India—90 Lane km.
3. First White topped project under PPP model.
4. Designed for 489 MSA.
5. Design Life of 60 years.
6. Project using Fibres for entire White topping of approx. 72,000 cu.m. of Concrete.
7. Project completed with least time & cost overrun, completed in 120 days using RMC.
8. Concrete Pavement is light in colour adding to luminosity during night, thereby saving Energy.
9. Project executed without cutting a single tree & saving environment.
10. Albedo effect—Surface being light in colour compared to Bitumen roads reduces surface temperature (Heat Island effect) having substantial effect in less heat radiation to the surroundings.
11. Savings in Natural Aggregates as Design life is 60 years.
Design & Construction Features
- Composite Rigid Pavement Construction with M-40 grade of RMC with designed Flexural Strength of 5.2 N/mm2.
- Use of Fibre Reinforced M-40 grade of Concrete for entire 72,000 cu.m. with the aid of Site based RMC plant of high capacity of 120 cu.m./hr.
- Highly mechanized Paver operation used for laying concrete.
- Effective use of Curing compound replacing conventional water curing system for concrete.
- No use of Dowel bars/reinforcements for the entire 90 lane km.
- Laying of concrete with joints/grooves of 1m x 1m panels.

Parameters	M-40 (opc+fibre)
Cement	430kg
20mm coarse aggregate	681kg
12mm coarse aggregate	435kg
Sand	739kg
water	160kg
Recron3S PP fibres	0.90kg
Admixture "Glenium ACE 30"	0.8-1%
Water/binder ratio	0.37
Unit weight	2445

Advantages

1. Water logging is a major reason for potholes in roads. WBM and Asphalt roads are permeable to water, which damages the road and sub grade. But PFRC roads are highly impermeable to water so they will not allow water logging and water coming out to the surface from sub grade.
2. Implementation of sensors in roads will be easier while using polymer fibres for concrete.
3. Environmental load of PFRC pavement was found to be significantly lower than the steel fibre reinforced pavement.
4. Maintenance activities related to steel corrosion will be reduced while using PFRC.
5. In fresh concrete polymer fibres reduce the

settlement of aggregate particles from pavement surface resulting in an impermeable and more durable, skid resistant pavement.
6. Fibres reduce plastic shrinkage and substance cracking. Fibres also provide residual strength after occurrence of cracking.
7. The use of PFRC produces concrete of improved abrasion resistance and impact resistance.
8. PFRC also enhances ductile and flexural toughness of concrete.
9. All these advantages result in overall improved DURABILITY of PAVEMENT & ensuring design life with drastic reduction in long term maintenance costs.

Limitations

The use of PFRC, being a relatively new technology poses a threat of a high initial cost of construction.

Application of PFRC

1. Slab On Grade: All types of pavements and overlays, industrial floors, roads, taxi ways, hangars,etc.
2. Structural Concrete: Foundations (deep and shallow), machine foundation, slabs, column beams and lintel, bridge decks and girders etc.
3. Water retaining Structures: RCC retaining walls, water tanks, cross drains, swimming pools, hydro projects, check dams, canal lining, ETPs, jetties, ports, spillways etc.
4. Water proofing in rooftops, sunken toilets, etc.

Conclusion

PFRC can be used advantageously over normal concrete pavement. Polymeric fibres such as polyester or polypropylene are being used due to their cost effective as well as corrosion resistance. PFRC requires specific design considerations and construction procedures to obtain optimum performance. The higher initial cost by 15-20% is counterbalanced by the reduction in maintenance and rehabilitation operations, making PFRC cheaper than flexible pavement by 30-35%. In a fast developing and vast country like India, road networks ensure mobility of resources, communication and in turn contribute to growth and development. Resistance to change, though however small, disturbs our society; hence we are always reluctant to accept even the best. It's high time that we overcome the resistance and reach for the peaks. PFRC opens a new hope to developing and globalizing the quality and reshaping the face of the "True Indian Roads".