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Application of geosynthetics to sub-surface water storage system

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ABSTRACT: India is a vast country with various environmental conditions. Some areas are prone to floods and heavy rains while some others are facing drought. The monsoon which is the prime source of rain in India is unpredictable and as such it is not currently found possible to distribute the rain water over the whole country. It is also found that some areas are adversely effected by heavy rains which is causing increase in pollution. This is likely to deteriorate in the coming decade.

New Methods of Storage of Flood and Rain Water:

Existing methods of storage of water by over surface dams causes submerging of large number of villages and dislocation of people living in those areas. Further, the ecological effects of building of such dams is not clearly understood.

There is lot of social resistence in the acceptance of the construction of such dams for prevention of floods.

With the advent of the Geo-synthetic technology, it is proposed to make a study on design of sub-surface water storage system where rain water can be stored with proper structural strength and distributed to the different areas by a network.

The present paper would bring out the need for such sub-surface based water storage systems for meeting the requirements of water in the post 2000 AD for agriculture, industry and drinking purposes and outline a methodology of a design for developing such water storage systems.

The authors would like to bring to the participants in the conference, proposal of case study for such sub-surface storages and the likely repercussions on the following factors:

1. Effects on the over-surface structures.
2. Resources involved for constructing such structures.
3. The distribution of water from underground reservoirs to the various users and also to avoid pollution and its effects.

In recent times, Geotextiles, Geomembrane and related products have had a significant impact on civil and Geotechnical engineering. These exciting materials provide new methods of improving performance and reducing costs for a variety of complex civil structures.. Like all engineering materials, however, they must be treated with respect. Design with Geosynthetics must be based on sound engineering principles and proper construction techniques. Specifications should be attended to appropriately and standard tests and procedures followed to determine the engineering properties of materials to be used:

A study has to be made on Soil reinforcement, Soil stabilisation, Filteration, Erosion control, Wastefill management, Landslide and Environment Protection, Non-woven Geotextiles, Geogrids, Geonets, Geocomposites, Geomembrane composites, Vertical strip Drains for utilisation in design of appropriate structures.

Appendix 'A' gives the functional details of various Geotextiles.

(11 Transparency Sheets)

Geotechnical research matured in the last few years for solving soil structure problems with minimum environmental impact. The significant developments in Geotechniques have resulted in Geogrids in soil stabilisation and soil reinforcement, Geonets and Geocomposites for drainage and subsurface storages, integrated system geogrids for realisation of high quality standardised structures.

In the next decade Geotextiles and related products will be extensively used for all conceivable applications in Civil Engineering. The Geosynthetics will provide a state-of-art alternative to conventional designs in rapid realisation in construction and installation of civil structures.

Various Civil Engineering organisations around the world have now realised the potential of Geosynthetics and extensive R&D work is being carried out. Further developmental works of large magnitude are already in advanced stages of implementation for Civil Engineering structures.

Geosynthetics which encompasses, Geotextiles, Geomembranes, Geogrids and Geocomposites may be defined as generic term which includes Geotextiles, Geomembranes, Geogrids, Geonets, Geocomposites and all other similar materials used by Civil Engineers to improve or modify soil/rock behaviour.

A Geotextile means any permeable textile material used with foundation, soil, rock, earth or any other Geotech engineering related material as an integral part of man made project structure or system. A Geomembrane can be designed as continuous membrane composed of asphaltic polymeric or combination of materials with sufficiently low permeability so as to con-

trol fluid flow in Irrigation and in Geotechnical engineering related man made project structure or system.

A Geogrid means any synthetic planar structure formed by a regular network of tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, earth or any other geotechnical material. They are also characterised by high dimensional stability and high tensile modulus at very low elongation.

When Geogrids/Geotextiles/Geomembranes are combined with woven or non-woven Geotextiles or Geogrids for specific applications like drainage, erosion control, bank protection etc., they are designated as Geocomposites.

Geonets/Geowebs/Geomats could be coarse woven/or joints obtained by partial melting made of strips, rigid filaments or extracted strands. They are generally flexible and junctions of overlapping strands not firmly connected.

Geotextile can be used for fluid transmission (liquid or gas) and conveyed along its own plane thus providing fluid transmission. This is also termed as drainage function.

Application for sub-surface, water storage systems:,

Geotextile, and Geogrids in internally reinforced soil walls allow reinforcement of soil mass creating a stable fill area between the wall face. This is similar to conventional cantilever retaining walls used in existing civil engineering structure. The use of Geosynthetics allows a significant reduction in concrete required, thus reducing the cost of wall construction and reduces the load carrying requiremet of the wall facing element resulting in the material and time saving. Further Geosynthetic reinforced systems are insensitive to caustic or acidic soils allowing the use of lower cost on site fills.

Geo-Synthetics assumed a very prominent role in India in recent years for the purpose of dams, control of seepage and prevention of evaporation and various other such sub-surface applications like sub-surface storage for materials, railways etc. India is a vast agricultural based country with a high population growth rate. As such the available land for agricultural cultivation should be preserved for meeting the food requirements of the country.

With the advent of industrial revolution, in India, in the last decade there is a massive increase in the requirement of water for drinking and industrial purposes in addition to agricultural requirement. In the earlier decades hydro electrical generation of power based on dams constructed over the surface on various large rivers resulted in the inundation of villages, dislocation of population, reduction of forest area thereby affecting the ecological balance in the environment. Indian water resources are replenished mainly by monsoon which is not a predictable source. Some areas in India are

prone to floods while some other areas are drought hit. As such existing levels of water in various dams are going out of control. A by-product of the dams in India is power generation. The hydro-electric power is heavily dependent on the replenishment of water in the dams. Due to the vagaries of monsoon, India is facing severe power shortage problem as the expected level of hydel power is not available to consumers, namely, industry, agriculture and domestic consumption. This will become much more stringent in the next decade as requirement of land becomes more and more prominent. During the last several decades several forests have been demolished for the purposes of laying roads, railway lines, dams, townships etc. If this trend continues the ecological effects from the environment in India becomes prominent.

This may cause increase in the ground temperature which in turn will result in the sea water raising and sub-merging of some of the urban areas which are shore based. In order to curtail this trend it is necessary to protect the current forests and trees and raise additional plantation.

In India there is a large requirement of land for shelter for the over 900 million population and also for the cultivation of various crops to meet the food requirement of the population. This is possible only if we plan to utilise sub-surface also for the purposes of storage of grain, water and other materials required for industrial applications.

A. WATER RESOURCES MANAGEMENT

Today there are various areas in India which are prone to floods and some other areas which are prone to drought. While the water from the rain may be adequate, the distribution of the water resources is not uniform. Water from Brahmaputra River flows into the sea whereas in some other rivers there is dwindling of water year after year. It is therefore necessary to network water resources available from different rivers through a central control point. A central computer based release of water for different areas will optimise the needs for agriculture, industries, drinking and drainage. While this is an enormous task, one approach which was till now not considered is by the development of suitable sub-surface tunnels. Such a course of action prevents soil erosion, inundation of land surface and also prevents loss of water due to evaporation. The authors would like to bring to the notice of this forum the new technical developments which are becoming feasible using Geo-synthetics for sub surface storage of water through various feeder lines from different surface areas of water. The computer controlled distribution of sub-surface stored water to various urban and rural areas by proper gravitation and pumping system is a major activity which needs massive planning, research and development. A balanced distribution of water can be provided to the needy population

living in different parts of the country under various types of terrains, namely hilly terrains, sandy terrains and other types of urban terrains where lot of industrial and domestic buildings are already built. The objective of the present paper is to make the participants aware of the relevance of Geosynthetic structures for the Indian Subcontinent and for evolving an optimum cost effective solution to meet the water distribution requirement in the coming decades without effecting the environment. The existing dams in India are over the surface submerging vast areas and dislocating a lot of population. There are also dangers of dam bursts and conditions of earthquakes and sabotage.

In reference to the above context, the authors propose to bringout networking of major rivers in the country and storing the water under railway tracks, forests, hilly terrains and agricultural lands. The requirements of water can be assessed and appropriately pumped up to the various needy people. This will not erode cultivable land, prevent destruction of forests, prevent ecological effects, prevent dislocation of people while utilising fully available potable water for various applications.

The storage of water under the surface can also be a solution for flood prone areas where the flood water can be channelised through underground tunnels to the storage tanks and prevent loss of potable water by evaporation.

B. CIVIL ENGINEERING INVOLVED

In order to generate such sub-surface channels for storage of vital water resources, gigantic civil activities are involved with proper structural designs using newer types of materials. It is now well established that cost effective structures can be realised quickly by use of Geosynthyetic materials on surfaces. Such designs using synthetic materials are proposed for sub-surface tanks. The structures also should be designed with cost effective columns which can be prefabricated and positioned at appropriate places so that a total sub-surface world can be created for accomodating the requirements of the growing population of Indian sub-continent. Virtual reality 3D - graphics can play a role in modelling & regulation of the flow of water in tunnels.

The English channel was built for road traffic from U.K to Europe under the sea. Similarly, the various sub-surface (under the sea) structures are planned elsewhere for human habitation as well as for civil and defence applications. It is an established technology for realising sub-surface channels. Dedicated sub-surface structures require a proper planning for realising quickly channels for storage of materials and water. Necessary funds and technology are needed in India for above applications.

The most important aspect in relation to India is the resource crunch which cannot afford to invest large volumes of funds for the purposes of

development of such sub-surface channels and water resources. It is therefore a point which the authors desire to discuss on the trends and material sciences which can be developed and made available by advanced countries to India so that the standard and quality of life for the population of India can be improved. While the authors have some design information on concrete sub-surface structures, and also using available abandoned mines, the authors recommend escavations in urban terrains under the large railway tracks, roadways and agricultural lands etc. so that the effect of such structures will be minimum on existing structures.

The authors would like the conference members to give a serious thought on the type of pollutants and the increase in the polution level caused in India by the various new industrial houses and structures which are coming up over the surface resulting in the depletion of various forest lands and cultivable lands. In the light of the above, the authors recommend to the international conference forum to come forward with plans and funds for realisation of sub- surface storage systems for different terrains in India.

TERRAINS IN INDIA

In India we have different types of soils - alluvial soils, black cotton soils, red soils, laterite soils, basalt soils, rocks, deserts, forests, agricultural, urban and rural roads and railways etc.

During the presentation of the paper, a typical case study will be discussed.

CONCLUSION

The basic objectives of Geosynthetics are:

a) To collect, evaluate and disseminate knowledge in all matters relevant to Geotextiles, Geomembranes and related products.

b) To improve communication and understanding regarding Geotextiles, Geomembranes and related products as well as their application.

c) To promote advancement of the state of the art of Geotextiles, Geomembranes and related products as well as their applications.

d) To encourage through its members of harmonisation of text method equipment and criteria for textiles, Geomembranes and related products.

RECOMMENDATIONS

It is recommended that in the light of availability of new types of Geosynthetic materials, work should be immediately initiated in India in the irrigation areas say sub-surface water storage systems with the participation of International Geosynthetic Society. Further the quality, test procedures & standardisation must be well defined and implemented.