(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
05 March 2020 (05.03.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/044355 A1

(51) International Patent Classification:
E02B 3/04 (2006.01)

(21) International Application Number:
PCT/IN2018/050690

(22) International Filing Date:
26 October 2018 (26.10.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201821032251 28 August 2018 (28.08.2018) IN

(72) Inventor; and

(71) Applicant: **SHAREDALAL, Hirenkumar Dhansukhlal** [IN/IN]; 201, Arpan Apartment, Opp. Kadam Bhavan, Nanpura, Surat 395001 (IN).

(74) Agent: **SHAH, Kavita**; F/2, Sarvamangal Complex, Opp. Pumping Station, New Sharda Mandir Road, Paldi, Ahmedabad 380007 (IN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,

(54) Title: INTEGRATION OF MULTIPURPOSE BOX TUNNELS WITH EMPTY LAKES AND MINI DAM FOR EFFECTIVE FLOOD CONTROL

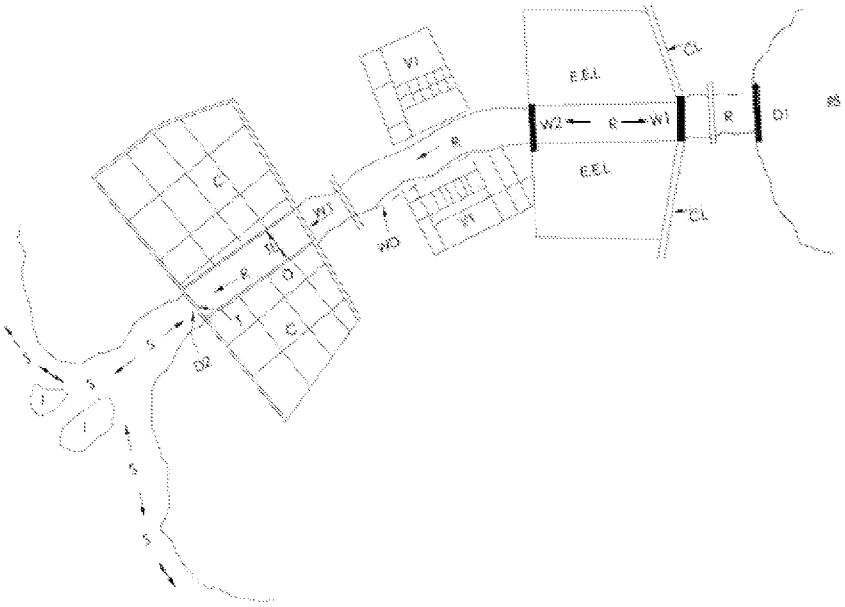

Fig. 1

(57) Abstract: The present invention relates to integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control which prevents water from flooding the river (R), and hence protects, the inhabited locations, near the banks of the river, from floods. It relates to areas like city and villages, having major dam (D_1) upstream and sea (S) downstream. Mini dam (D_2), prevents the intrusion of sea water into the river, even at highest tide, and ensures the discharge of flood water, directly into the sea through multipurpose box tunnels (T), even during high discharge of flood water from major dam (D_1) upstream and high tide simultaneously. The empty lake (EEL) and multipurpose box tunnels (Te) constructed as embankments, store water for emergency and utility purposes. Small box tunnels (D) discharge, drainage directly into the sea. Multipurpose box tunnels are surfaced with roads (Rd), increasing connectivity.

WO 2020/044355 A1

[Continued on next page]

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

TITLE OF THE INVENTION:

Integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control.

FIELD OF THE INVENTION:

The present invention relates to a flood control system, which prevents water from flooding river, and from entering and causing damages to inhabited locations such as, cities or villages, present, on and near the banks of the river, having major dam on its upstream and sea on its downstream. This involves construction of multipurpose box tunnels, empty lakes and mini dam, along and across the banks of river, which prevent, the intrusion of sea water into the river tail area, even at highest tide, and ensures the flow of river water being discharged directly into the sea, without flooding, areas on and near banks of river, even during heavy rainfall and high discharge of flood water from major dam upstream. Empty lakes are created on the river pathway, to store excess water discharged from major dam, during the flooding of the river so that the water from the river does not enter the inhabited land area, thereby preventing them from floods. The empty lake also stores water of the river for utility purposes, after the end of monsoon and before the start of next monsoon, to be helpful, even during drought conditions. The multipurpose novel box tunnels which are built, in lieu of embankments, (to prevent flood water from entering low lying areas), will store and supply utility water and small box tunnel will discharge drainage directly into the sea, keeping the river pollution free. Multipurpose box tunnels are, also, surfaced with roads to increase the connectivity of areas near the river.

BACKGROUND OF THE INVENTION:

Flood is an overflow of water that submerges land that is usually dry. Flood can be caused due to an overflow of water from water bodies such as river, lake or ocean by overflowing through its usual boundaries. Floods are caused by many factors or a combination of more than one factors namely prolonged heavy rainfall, highly accelerated snowmelt, severe winds over water, unusual high tides, tsunamis, failure of dams, levees or retention ponds or other such structures, etc. Floods usually occur when ponds, lakes, riverbeds, soil and vegetation cannot absorb all the rainwater. The common cause of flood is heavy rain which exceeds the capacity of water flowing in rivers due to which water overflows the boundaries of the rivers and enters the land area causing flood. This overflowing is mainly caused at bends of the river or locations where the river path becomes narrower. Some floods develop slowly while others such as flash floods can develop in just a few minutes. Floods can be local, impacting a neighbourhood or community, or very large, affecting a large population.

Flooding mainly damages property and endangers the lives of humans and other species. Apart from this, flooding causes soil erosion, sediment deposition, pollutes and destroys the natural habitat of aquatic life, hampers the routine life of people, damages crops and farms etc. causing great financial loss. As such controlling the flood is the most important matter.

Flood control methods have been developed and used since ages, to reduce or prevent the detrimental effects of flood waters. The basic methods to control flood included planting vegetation, terracing hillsides to slow the flow downhill and construction of floodways which are diversions created to divert flood water. Other methods include the construction of levees, lakes, dams, reservoirs, retention ponds etc. to hold the water during flooding and/or to be used in drought conditions.

Levees are naturally occurring ridges or artificially constructed fills or walls which regulate water levels. The main purpose of artificial levees is to prevent flooding of the countryside adjoining the water body and slow down the natural course changes in a waterway to make it useful for shipping.

Artificial lakes or **reservoirs** are manmade water bodies, used to store water, usually rainwater. This stored water can be used for daily activities, for commercial purposes as well as for recreational purposes.

Dams are barriers that stop or restrict the flow of water or underground streams. They reduce the peak discharge of flood water created by large storms or heavy snowmelt. Dams not only suppress floods but also retain water for activities like irrigation, human consumption, industrial use, aquaculture, navigability, hydropower etc. Dams are used to collect water and store it which can be supplied for use to different locations.

Retention ponds, also known as wet ponds are artificial lakes with vegetation around their perimeter. Such ponds are used to manage storm water runoff to prevent flooding and downstream erosion and improve the quality of water in nearby river, stream, lake or bay.

A number of patents and patent applications are available in the prior art, which provide different methods for controlling flood.

US Patent 5788410 describes a mobile underflow spill recovery unit which provides a barrier to pollutants floating in runoff water which otherwise finds its way into storm drains and streams. The mobile underflow spill recovery unit includes a dam disposed between limiting sidewalls, and a baffle spanning between the sidewalls above the dam. The baffle's lower limit extends below the height of the dam, forming a weir channel between the baffle and the dam. Floating pollutants become trapped against the baffle while hydraulic pressure allows subsurface stream

water to flow through the weir channel and over the dam. In one embodiment, a plurality of portable emergency dam units may be bolted together and installed through a temporary dirt levee built across a flowing stream or ditch to capture pollutants spilled upstream. In another embodiment, the conventional curb-level inlet to a storm sewer catch basin is replaced by a surface grate which drops runoff water into a chamber buried adjacent the catch basin. The chamber includes a dam disposed beneath another opening leading into the catch basin. A baffle disposed over the dam forms a weir channel, and the baffle may be adjustable for peak flow rates. Means to suppress churning of water pooling in the chamber by incoming runoff may be provided below the inlet grate, and access means to the chamber interior allows for siphoning off trapped pollutants and for adjusting the baffles. A mobile alternate embodiment includes a vehicle for rapid transportation of an emergency underflow dam recovery unit to a spill site, the vehicle further being equipped with ancillary pumps, hoses and a valved manifold for treatment of polluted water on the vehicle and release of cleaned water into a stream.

US Patent 6312192 discloses a flood control barrier for separating water in a wet area from an area to be maintained substantially dry comprises a flexible exterior membrane made of liquid impervious material and including elongated upper and lower membrane sections joined at a closed longitudinal downstream end of the exterior membrane opposed to an open longitudinal upstream end thereof. The upper and lower membrane sections are connected by internal partition walls and are displaceable between expanded and collapsed positions, wherein in the collapsed position, the upper membrane section overlies the lower membrane section, whereas in the expanded position, the upper membrane section is spaced from the lower membrane section at the open end of the exterior membrane such that water may flow through the open end and be received between the upper and lower membrane sections such as to be trapped therein, i.e. by

the closed downstream end thereof which prevents the water from flowing past the barrier. A float may be provided at an upstream end of the upper membrane section such that as water flows towards the barrier, the upper membrane section rises with a level of the flowing water while maintaining the upstream end above the water level. Alternate embodiments include mechanical retention systems and an elongated seal.

US Patent 7435036 gives a flexible water gate that is suitable for retaining water in a port, canal or river estuary. The gate is both economical to build and maintain and comprises a gate controller that allows a flexible member to be controllably moved between a closed and open position, as required. A flexible flood control barrier that comprises one or more of the aforementioned flexible water gates is also described. These gates are deployed side to side and provide an economical way of providing flood protection to an area susceptible to flood tides. When not in use the flexible membranes of the flexible water gates can be stored on the riverbed so permitting unrestricted access for marine vessels.

US Patent 9279224 relates to a series of self-actuating flood guard units each including a buoyant gate flanked by a pair of the boundary walls and pivotable about a horizontal axis transverse to the flanking boundary walls which runs along a shoreline of an adjacent body of water. The axis is located at a selected elevation above ground inundated by the body water and is selected to cause the gate to buoyantly rotate upwardly between the boundary walls on rise of water above the selected elevation. The extent of rotation is limited by a restraint acting on the gate.

KR 101267377 provides a natural water storage system for preventing flood to preventflood by discharging overflowing river water to a river after temporarily storing the overflowing river water in a water storage tank with a non-power mode. A natural water storage system for

preventing flood comprises a floodwater level forecast line, a floodwater level line, a small river inlet pipe(100), a rainwater chamber(200), a first settling basin(211), a washing tank(300), a water storage tank(400), and a water level sensor. The floodwater level forecast line and the floodwater level line are formed in order to show the water level of a small river. The small river inlet pipe draws water of the small river between the floodwater level forecast line and the floodwater level line and filters the adulteration with a screen device(110). The rainwater chamber draws the river water through the small river inlet pipe and comprises an opening and a closing plate(210) on the upper end. The first settling basin filters the sludge with the movement of the river water. The washing tank gradually stores the water with a washing tank overflow protrusion(310). The water storage tank stores the water with a water storage tank overflow protrusion and discharges the stored water through a discharge pipe(412). The water sensor is included inside of the washing tank and moves the water by opening or closing the hydraulic floodgate according to the water level.

JP 11-229356 discusses a movable weir and gives a method to prevent breakage of a weir by a flood by providing a support part (strut) disposed in an opposite bulkhead of a river with a weir member, the center part of which is connected to be separable in such a manner as to freely turn, and opening the weir by flowing water force when a flood occurs. In case of water famine, a pair of weir members 3, 3 are joined to each other by a connecting part 4, and a river is dammed to store water on the upstream side of the weir members 3, thereby keeping the habitant environment for fishes, plants or the like. On the other hand, in the case where a water flow is increased by a flood or the like, the connecting part 4 is separated, the weir members 3 are turned on a support part 2 to be opened. The respective opened weir members 3 are drawn to the bulkhead side by each recovery rope 5 and fixed. Thus, resistance of water is reduced to prevent

the movable weirs 3 from being broken. In recovering from the flood, the weir members 3, 3 are returned in the cross direction by human power to put the connecting part 4 in the connecting state. Thus, the risk of a flood can be reduced.

JP 2016-079775 discusses a flood prevention weir which can prevent an overflow even when high waves surge in and which can prevent an increase in size even in the case of preventing an overflow of high waves. A flood prevention weir 1 comprises a bottom surface part 2 and a weir wall part 4 each made of a waterproof sheet, and the deep end part of the bottom surface part 2 and the lower end part of the weir wall part 4 are formed integrally in a state that the weir wall part 4 can stand from a lodging state by the flexibility of the waterproof sheet. A core material storage part 5 is installed in the weir wall part 4, and a core material 6 is stored from a point near the lower end part to a point near the upper end part of the weir wall part 4. By connecting the top face of the bottom surface part 2 to the front side of the weir wall part 4, a restriction partition wall part 7 for restricting the angle of the weir wall part 4 in standing is installed, and a weight 8 is arranged in the bottom surface part 2.

CN 104612237 provides a rainfall flood regulating system which comprises a draining aisle, a rainwater inlet is formed in the left end of the draining aisle, an outlet for rainwater to be processed is formed in the right end of the draining aisle, a draining opening is formed in the front side of the draining aisle, a draining control weir gate is arranged at the draining opening, and a first level sensor is arranged in the draining aisle. A first regulation and storage tank and a second regulation and storage tank are arranged on the rear side of the draining aisle, a first overflow structure is arranged between the draining aisle and the first regulation and storage tank, a second overflow structure is arranged between the first regulation and storage tank and the second regulation and storage tank, a front water passing channel is connected between the

first regulation and storage tank and the second regulation and storage tank, a one-way check valve is arranged on the front water passing channel, a submersible sewage pump is arranged in the first regulation and storage tank, and the water outlet end of the submersible sewage pump is connected with the draining aisle. Rainwater and the flood peak in the middle period are regulated in time while initial rainwater is separated, pollution of the initial rainwater and city and town waterlogging are effectively prevented, and regulation and storage are safe and reliable.

CN 105862680 gives a flood control weir. The weir comprises a main dam stretching across a river and further comprises a base dam, a gate and a driving device, wherein the base dam stretches across the upstream position of the main dam, and the base dam is lower than the main dam; the gate is rotationally arranged at the upper end of the base dam; the driving device is connected with the gate and is used for driving the gate to rotate towards the upper side of the base dam or the lower side of the base dam. With the adoption of the weir, the base dam is arranged above the main dam, and when the main dam is dismounted, the base dam can intercept a certain amount of water flow, so that flood influencing the downstream position is avoided; besides, the base dam is lower than the main dam, and thus ship sailing can be guaranteed.

Indian Patent Application 1381/DEL/2013 provides a mini overflow concrete gravitational dam/ weir for storing the river water by making optimum use of gradient and the embankment that border the river, wherein: a. the cascade commences from the river mouth and then proceed upwards, in series; b. raising the embankment along the banks to a height higher than the dam section to an extent that is required for passing the design flood discharge of the river along the gradient till it tapers off to zero height so as to hold substantial amount of water; c. providing

sluice gates for regulating the movement of silt during the peak period so as to avoid silting of reservoir and also to conserve the nature of river flow.

Although a number of flood control methods are available in the prior art, an integrated system, which facilitates and controls flood more effectively, by discharging of required excess river flood water into the sea, even at times of highest tide and during excessive rainfall when huge volume of water is simultaneously discharged from main dam, by construction of multipurpose box tunnels and mini earthen dam, across the banks of rivers, along with, construction of box tunnels adjacent to and all along (in lieu of Embankments) both banks and by storing the water at times when, water discharged from main dam is endangered to flood the areas nearby, into emergency empty lakes, which control the amount of water flowing down into the sea by construction of novel underflow weir, is the need of the day.

OBJECT OF THE INVENTION:

The main object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control wherein the multipurpose box tunnels are placed on mini dam just above highest tide level, such that the water from the river can always flow through these box tunnels into the sea, while the sea water can't enter the river path or nearby areas even during highest tide and wherein the flow of flood water in the river downstream is controlled by the creation of emergency empty lake which is developed downstream of main dam and upstream of inhabited areas like city and villages or even airports etc., which will be used to store, flood water discharged from main dam, only in case of emergency, for effective flood control and wherein multipurpose box tunnels are constructed as

embankments adjacent and all along, both the banks of the river, and are used to store, utility water from the river which can be supplied to various areas of city nearby the banks of river thereby assisting in supply of water to far areas at reduced capital cost towards water supply and system.

Another object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control in which multipurpose box tunnels are made of RCC and have roads built on their surface for better connectivity between and within different cities and villages lying on the banks of the river thereby easing traffic problems.

Still another object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control in which the multipurpose box tunnels built on the mini dam are built at a height above the highest tide level, which allows uninterrupted flow of the river water discharged into the sea even at time of highest tide.

Yet another object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control in which the multipurpose box tunnels built in the mini dam, at the normal tide level, are provided with gates, such that water from the river can flow in the sea while sea water can't enter the river path or the villages and cities lying on the banks of the river.

A further object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control in which multipurpose box tunnels used for making embankments on both sides of the rivers are RCC boxes in which large volume of water for utility purposes can be stored and can be used for supplying to nearby cities and villages.

A still further object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control wherein the embankments have smaller similar RCC boxes nearer the river bank which can be used to collect drainage from industries, cities and villages to be dispensed directly in the sea beyond the mini dam.

A yet further object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control wherein the emergency empty lakes are built on the river with overflow weir on its start point upstream, and underflow weir on its end point downstream, which controls the flow of river water and allows normal course of water in the river to flow routinely while restricting the flow of water during flooding of water such that water gets stored in these empty lakes during emergency, by closing the gates provided in lower portion of underflow weir.

A further object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control which also assists in storing water and providing it for utility purposes during scarcity or drought conditions and also reduces salination of water table near the sea but within the site of mini dam.

A still further object of the invention is to provide integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control which is essential for cities and villages lying on river banks, and is economical compared to other flood control methods.

SUMMARY OF THE INVENTION:

The present invention relates to integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control, which controls the water of the flooding river or sea from entering the cities or villages lying on their banks and having major dam upstream and sea

downstream. For this purpose, an earthen mini dam is constructed near the tail of the river on which multipurpose box tunnels without any gates, are provided at a height, greater than the highest tide level in the sea, such that river water can freely flow in the sea while sea water can't enter the main river path. Multipurpose box tunnels with gates are also provided in the mini dam between the highest tide level and the normal tide level, wherein the gates are designed such that they allow, only river water to flow in the sea whenever needed. Emergency empty lakes with overflow and underflow weirs are constructed on the river path between the main dam upstream and inhabited areas like city downstream such that emergency lakes remain empty normally but can be used to store water in emergency conditions, when huge volume of water is released from the dam upstream and water cant flow down the river into the sea due to high tide in the sea, by closing the gates provided on lower portion of underflow weir built on downstream end of emergency lake. The water stored in these lakes can be gradually released downstream, only when the high tide starts receding upto the low tide only. Embankments made of multipurpose box tunnels are also constructed on both sides of the river which can store water for utility purposes and make facilities for dispensing drainage directly into the sea. All the multipurpose box tunnels can be surfaced with roads improving the connectivity between and within cities and villages.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 represents the flowing river with the constructions of the present invention.

Fig. 2 gives the diagram of the multipurpose box tunnel prepared on the mini dam.

Fig. 3 gives the diagram of the gates of the multipurpose box tunnel built in the mini dam.

Fig. 4 gives the diagram of the underflow weir built on the exit path of emergency empty lake.

Fig. 5 gives the diagram of the roads built on the multipurpose box tunnel.

DETAILED DESCRIPTION:

The nature of the invention and the manner in which it is performed is clearly described in the specification. The invention has various components and they are clearly described in the detailed description.

Throughout the world, cities or villages lying on the banks of natural water bodies like rivers, and sea, are in constant dread of being flooded in monsoon due to heavy rainfall and or due to discharge of water from major dam on upstream. These include the cities and villages at higher altitudes, through which a river having greater water discharge flows. Melting of snow in summers is also a cause of flooding in nearby inhabited locations. Floods are a natural disaster which causes great damage to one and all. People and animals may lose lives, farmers may lose crops, buildings and other structures may get damaged, vocation of many gets affected thereby causing huge economic loss. Various flood control measures have been developed and applied in the cities and villages by the Government as well as by the people, but many a times, all such efforts go in vain resulting in great damage and losses. Especially for cities and villages, lying near the sea, and upstream of the river, having larger water volume flow. Such places are prone to being flooded often. Flooding also occurs in rivers due to narrowing of river bed due to siltation or due to improper time management with respect to inflow of water from the river into the sea and situation of high tide at the sea. Flood control systems need to be developed after considering all these causes and their effects.

The present invention describes an integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control, as shown in Fig. 1, which prevents flooding of

cities or villages lying on the banks of rivers or seas or oceans. As rainfall is the basic source of potable water and water flowing in rivers is normally used for basic needs of mankind, the present invention, along with preventing flooding of inhabited areas, helps in conservation of water for use by mankind, prevents salination of river water by blocking the entry of sea water during high tide, in the downstream flowing water of the river and provides flat and wide box tunnels for easy and ensured discharge of flood water from river into sea. Moreover on these box tunnels, roads can be built to ease traffic flow.

As shown in Fig. 1, D_1 is the main dam upstream through which the river flows wherein R indicates the natural river flow through the dam. C_L is the canal downstream of the dam on the river. This canal has an overflow weir W_1. The emergency empty lake EEL, is constructed from W_1 by excavating both sides of banks of the river, to store water in cases of emergency. The lake ends in the naturally flowing river to which it is connected through W_2 which is an underflow weir. The river flows down through the underflow weir on its natural course and passes through villages V_1 and cities lying on its banks. The river width Wr is widened, wherever possible to increase the volume of water flowing through the river. Before the tail of the river, a mini dam D_2 is constructed with multipurpose box tunnels T. These box tunnels have roads on top. The flood water discharged from river flows through these open ended box tunnels, into the sea, S. The detailed working of the invention is described further.

The present invention for controlling flood is divided in three phases.

In the first phase, of the system of the present invention, efforts are made to control flood as well as the salination of the river water by preventing the entry of the saline sea water in the river. As the river flows close to the sea, it gets exposed to saline water from the sea since ages due to high tides, making the river bed salty. Due to this, the ground water in the nearby

locations also becomes salty and unfit for consumption. To reduce and remove the salinity from the river water and the ground water gradually, mini dam of height little more than highest tide level is built across the river and hence no saline sea water can enter riverside and shall not salinate river any more. Moreover sweet water from river is now filled in upstream of mini dam which will help to nullify the salinity in these areas.

To build this mini dam, which should preferably be an earthen dam, lots of earthen matter is required. As such, to improve the quality and quantity of water flowing in the river, desilting and dredging of the river is done. The process of desilting removes the suspended silt from the river. For this purpose, dredging of the river is done with the help of ultramodern machines available these days, to excavate the deposited silt, mud, weeds etc, from the river bed, thereby deepening the river and increasing its water carrying capacity. Dredging also keeps waterways navigable. The excavated material, obtained from dredging of the river bed is used to make a mini earthen dam D_2 as shown in Fig. 1, which will prevent the water of the sea from entering the river, even during highest tide because of the height of mini dam which is more than highest tide level ever. This mini dam is constructed approximately 1 to 2 kms away from the sea near the river's tail, covering an economically viable, wider length across the river, to allow maximum possible discharge into the sea.

For this purpose, the height of the highest tide level HHTL from the sea is determined and according to this height, a small dam is built above the determined height across the river. As shown in Fig. 2, the mini dam D_2 is built after determining the HHTL, uptill 0.5 meters above the highest high tide level H_1. This dam doesn't have any opening uptill 0.5 metres more than the HHTL. The excavated matter, obtained from dredging of the river bed, is used to build the small dam at lower cost. This dam D_2 prevents the entry of water from the sea into the river, even

when the tide is the highest. Due to this, the river water wont become saline in future. Moreover, gradually, the ground water too will lose its salinity and thus the water will become potable. This dam D_2 also helps in conserving the river water for human use and prevents all the water from being discharged into the sea. Thus more water will be available for utility purposes and will fulfill the need for developing areas in and around the city or village. Water recreational projects can also be developed.

However, when the volume of water flowing in the river is higher, the excess water can flow over this mini dam D2 into the sea normally but will erode the top of the mini dam. To prevent such erosion, multipurpose box tunnels T, as shown in Fig. 2, are built on the top surface of the dam. These tunnels are made of RCC and have openings at both ends, which allow the flow of flood river water into the sea at and above highest tide level. Thus, even in case of flood in the river, due to heavy rainfall, the excess water flows uninterrupted into the sea. The multipurpose box tunnels are designed in the shape of Ventury Tube V from inside, which allows faster flow of water from the river into the sea so that when the water level in the river is rising fast, it gets immediately disposed off into the sea, without flooding the inhabited locations on the bank of the river. Moreover roads Rd can be built on the top surface of these multipurpose box tunnels T, connecting both the banks of the river, which help in solving the traffic problems and increase connectivity within and outside the cities and villages leading to the development of the city. These multipurpose box tunnels also prevent erosion from the surface of the mini dam.

The multipurpose box tunnels provided above the small earthen dam helps the river water to flow out into the sea only when it reaches above the highest tide level. However, if the river is full of water and a major dam present upstream is also full with water, water needs to be released from the dam D_1 into the river as a precautionary measure. In such conditions, water needs to be

immediately discharged from the river into the sea, even if its level is below the highest tide level. To accomplish this task, additional box tunnels T_1, are provided in the central part of the earthen dam D_2, along 30% to 40% length of the small dam, above the normal high tide level H_1. These multipurpose box tunnels have gates G with specially designed features as shown in Fig. 3, wherein the gates G will be dropped down from the axle A_1 and A_2 mounted at the top of the box tunnel from the historical highest flood level HHFL, and will have swivel movement with shock absorbers Sa, fitted near bottom of gates inside box tunnels on riverside of gate, which will absorb the shocks when the gate is dropped down to close, preventing the damage to other structure and will also prevent it to move towards riverside by a single degree. Hence this gate cannot open towards riverside. As such it is named as one directional gate which has opening towards the sea side only to allow only river water to flow towards the sea and not vice a versa. These gates will normally be kept vertically down in closed position C, by locking system L. But when water is to be released from upstream dam into the fully filled river R, the mechanical locking system of the gates is released to open O them with the help chain linked with the driving motor D. This is done only during low tide level LTL in the sea S. As soon as the gates are unlocked, pressure of water flowing in the river R will push open the gates and open them upto 80 degree inclination on the sea side. This will allow the water from the river side to flow into the sea, even when the water level in the river is below the highest tide level HTL and the sea is at low tide level LTL. As soon as the flow of water in the river is normalized and no excess water is flowing or being released from the dam, the gates of these multipurpose box tunnels will get closed automatically due to self weight and reduced outside pressure, and will be locked automatically, due to angular resistance of locking plate. As these gates are designed to open O only on one way, i.e. towards the sea, during average high tide level AHTL, even if the water of

the tide applies pressure on these gates, the gates will remain closed C and sea water wont be able to enter the river through them. However, from the gateless tunnels above the mini dam, river water can be discharged in the sea even during high tide resulting in uninterrupted flow of flood water from the river into the sea thereby preventing flooding of the sea and nearby villages.

However, when there is very heavy rainfall, the dam D_1 present on the upstream of the river gets overflowed, leading to very high volume of outflow of water from the dam in the river. This excessive volume of water in the river, along with heavy rains, will overflow the banks and ruin the cities and villages lying nearby, by flooding them. During such heavy rains, the tides in the sea are also very high, due to which water from the river may not be able to be discharged through the box tunnels provided on the top of the small earthen dam D_2. Hence, the phase 2 of the present invention is implemented, to tackle such situations and ensure safety of life and property of the people.

The second phase of the present invention involves the construction of emergency empty lakes EEL with underflow weirs W_2 along the main river stream, to tackle the problem of heavy flooding in the river during high tide in the sea. For this purpose, the breadth of the river is widened by excavating sides of the river bank upto required area and having storage capacity calculated with factor of safety. Emergency empty lakes are usually developed in areas of lower inhabitation where the land is cheaper and easily available.

Emergency empty lakes are constructed surrounding the river at locations such that it remains empty through out the whole year and the water flows normally through this lake, along the course of the river. Underflow weir W_2 is constructed, at the lower end of this lake, to control the flow of water through this lake. As shown in Fig. 4, this underflow weir has gates in the lower portion of the weir, touching the river bed, which are kept open GO throughout the year so

that the river water flows normally through these lakes and down the weir and follows its natural course downstream. Hence the emergency empty lakes remain empty. However, when heavy flooding occurs upstream and due to high tide in the sea, the flood water can't go downstream and flow into the sea. In such situations, all these gates of underflow weirs are closed GC, as shown in the fig. 4, to accumulate water in these emergency empty lakes and save the cities and villages lying downstream of the lake and upstream of dam D_2, from flooding. The underflow weir W_2 is made of RCC and roads Rd can be built over this weir to connect one side of the river with the other. These emergency empty lakes should be so broad and deep that they can accumulate a very huge volume of water which is more than the amount of water that can flood an entire city. Thus the cities and villages lying on the banks of the river downstream will be protected from being flooded due to this accumulation of water in the emergency empty lakes even when water cannot be discharged into the sea, at highest tide times in the sea. After monsoon is over, the water stored in these emergency empty lakes can be used for utility purposes for nearby cities and villages by developing water works systems. Otherwise, when the flooding upstream gets reduced and tides in the sea get lower, the water stored in these emergency empty lakes can be released gradually by opening the gates of W_2 and allowing the water to pass from below into the river downstream and through the earthen dam D_2, through the multipurpose box tunnel into the sea. Thus cities and villages downstream of empty lake will be protected from flood.

Emergency empty lakes are created by excavating the area around both sides of the river in the area proposed for construction of the lake, uptill the river bed. The excavated earth is used to construct the earthen wall on the boundary lines of the proposed lake. Such lakes will remain empty throughout the year and will be used for storing water only in conditions of emergency

and so are named as emergency empty lakes. When all other structures protecting the city or village from flood are being used to protect the city and more water is being discharged from the upstream dam, which is to be disposed, this emergency empty lake is filled to its full capacity by closing the gates of their underflow weir W_2. Due to this, the flood water which would have otherwise flooded the cities and/or villages, gets stored in these emergency empty lakes. One or more such lakes can be constructed at various locations to protect nearby cities and villages from flooding. These lakes are standby lakes to divert and store flood water which would have ruined cities and villages and took a heavy toll on lives and property.

The capacity of an emergency empty lake must be at least, 50% more than the estimated quantity of water to be discharged. To achieve this value, a survey of water quantity which flooded the area in the past is done and 50% excess is added to the highest volume of flooded water, to calculate the capacity of the emergency empty lake. While calculating the capacity, the duration and timing of high tide is also to be considered. Such lakes are constructed on the river along the natural flow of the river and are constructed by excavating the banks of river in the areas where human population is less due to which the land is cheaper and easily available.

Once the location of Emergency Empty lake is finalized, an overflow weir W_1 is constructed upstream on the river, at the location from where the lake starts and from where river flows normally in the emergency empty lake. Similarly, an underflow weir W_2 is constructed downstream on the river, at the location from which the river flows normally out of the lake. A broad area of land around the river is selected between W_1 and W_2 and is excavated uptill the river bed to construct the emergency empty lake. The excavated earth is used to increase the height of the lake by preparing its boundary. In W_2, gates are provided as shown in Fig. 4, on the lower part of the RCC weir. These gates remain open GO throughout the year and allow normal

water to flow through them. However, in case of emergency, i.e. heavy flooding upstream and high tides in the sea, the gates of W_2 are closed to fill the emergency empty lake with water and save the nearby cities and villages from flooding. These gates are closed GC using auto locking system and when closed, the flood water discharged from dam D_1, wont find any way downstream beyond W_2 and so will be filled in the emergency empty lake. When the high tide in the sea, starts receding, and water level in the river downstream of W_2 decreases, the gates of W_2 are opened partially (as per the requirement), to release the flood water stored in the emergency empty lake in the downstream flow of the river, so that it gets discharged in the sea. This allows further storage of flood water which has been discharged from D_1, in the emergency empty lake. However, caution should be taken to close the gates of W_2, at least 30 minutes before upcoming high tide in the sea so that the downstream flow of water in the river is controlled and level is maintained below the danger mark to keep the nearby cities and villages out of danger from flood. The process of release of water from emergency empty lake by partially opening the gates of W_2 should be repeated cautiously until the outflow discharge from dam D_1 is reduced to normal flow and water level downstream of W_2 is also normal. However this release of water should be done gradually such that water release is started when the high tide in the sea starts receding. At the end of the monsoon season, this emergency empty lake can be allowed to store upto 70% of its total capacity of water which can be used for utility purposes for the rest of the year. This way, the emergency empty lakes along with mini dam of the present invention, can be used to protect mankind from both drought and flood.

Even if we construct the structures in accordance with phase 1 and phase 2 of the present invention, water flowing in the river can flood cities or villages lying on their banks by overflowing the low lying banks or through creeks of rivers. Usually embankments and other

similar structures are constructed on river banks to solve the problems of overflowing and/or punctured banks of rivers. The phase 3 of the present invention provides a solution to these problems.

In the phase 3 of the present invention multipurpose box tunnels Te with roads on top and water supply through the tunnels are to be constructed to be used as embankments to prevent flooding of cities and villages on both the sides of the river. In this phase, as shown in Fig. 5, RCC box tunnels Te are constructed on foundation all along the banks of the river R on both the sides, right from the main upstream side of the city upto the mini dam D_2, perpendicular to the width of the river SS_1.The height of these box tunnels is determined according to the flow of water in the flooding river such that it doesn't enter nearby cities or villages. Roads Rd are built on the surface of these box tunnels such that nearby buildings B, different cities and villages lying on the banks of the river get connected with each other. These roads can further be connected with internal roads of the cities and villages. Large volumes of water can be stored in the hollow portion of the multipurpose box tunnels Te, closed at ends, beneath the roads Rd, for utility purposes of nearby cities and villages. Water works for neighboring cities and villages can be developed due to these box tunnels improving the supply of utility water as well as decreasing the capital cost of water supply system and maintenance costs.

The embankments built normally require a wider base, which reduces the water carrying capacity of the river while the multipurpose box tunnels Te of the present invention require lesser width, thereby increasing the normal water carrying capacity of the river. Part of these box tunnels can be developed as riverfronts where number of recreational activities can be introduced.

The smaller box tunnels of the present invention can also be used to develop the drainage system of cities and villages. Usually, in developing countries, the domestic and industrial waste of any city or village, discharged in the drainage system, is released in the river flowing through it, thereby polluting the river. In the present invention, while constructing embankments using RCC box tunnels Te, similar small RCC boxes D, totally closed from all four sides, are constructed parallel to the multipurpose box tunnels Te and between the river and the main multipurpose box tunnels Te. These are named as Drain Box Tunnels D. All the drainage pipe lines of the nearby cities or villages, having openings in the river, are instead connected to these drain box tunnels D. Such drain box tunnels are constructed throughout the river bank on both sides of the river and will start from D_1 and will go upto the downstream end of the river beyond the mini dam D_2, discharging wastes directly into the sea S, so that all pollutants are discharged without polluting the utility water of the river. Due to the direct discharge in the sea, backflow of the drainage becomes negligible and hence city remains cleaner and non polluted in monsoon also. These drain box tunnels reduce the pollution of the rivers, making the cities and villages, cleaner and healthier. As no drainage is discharged in the river, negligible biomass develops in the river making it cleaner such that it can be used for utility as well as recreational purposes.

The above mentioned invention can be more clearly explained with the help of the following example.

Example: In India, Surat is a big city situated on the banks of the river Tapi and close to the Arabian sea. It is a city prone to being flooded due to the heavily flowing Tapi river and the sea coast. Surat city has seen many floods since the 20^{th} century due to heavy rainfall and over flowing Tapi river following release of water from Ukai dam, present upstream on the river. There is another dam on the river Tapi. Ukai is the bigger dam present upstream while Kakarapar

is an overflow weir, downstream of Ukai dam and upstream of Surat city. In monsoon, due to heavy rainfall upstream, when the Ukai dam is full upto rule level, the excess water from the dam has to be released, in the river downstream. On 6th August, 2006, due to heavy inflow from catchment area, more than 5 lac cusec water was discharged from Ukai dam in the river Tapi. But 8th August, 2006 was the day of very high tides. Sea water from the Arabian Sea rose high and did not allow the flood water run into the sea. Hence flood waters, overflowed from banks of river Tapi and entered the Surat city as well as nearby areas. Moreover, water was continuously being discharged in the river from the Ukai dam due to heavy inflow. This led to flooding of Surat and nearby areas as water came from both the sides, from the river as well as from the sea and caused great damage to lives and property.

To protect Surat from such disaster in future, the constructions of the present invention should be implemented as follows:

- A mini dam D_2 of 3mt height should be constructed near ONGC bridge at Magdalla, Surat, with multipurpose box tunnels on it as described before at the height above the highest tide level of the sea during the August 2006 floods, wherein the road constructed on this tunnel widens the ONGC bridge thereby solving the traffic problems in Surat city;
- Creating empty lakes on the river Tapi, with overflow/underflow weirs, at Mandvi, Bodhan and Bhairav which can store large volumes of water being discharged from Ukai dam during flood and release it slowly when the flood situation downstream is under control or can store the water which can be used later for utility purposes wherein the locations selected are such where the land isn't in use and is available at lesser cost.

For the construction of empty lakes, its capacity needs to be determined by taking into account the largest quantity of water which has flooded the city. The quantity of flood water which entered the Surat city and nearby villages on 8th August, 2006 was estimated by taking average level of HFL to be not more than 3 mt and area affecting to be an average of 10 km by 5 km, summing it up in a rectangular shape. Therefore the quantity of flood water which had entered Surat city = 10 km x 5 km x 3.00 m

$= 150000000\ m^3 = 150$ mcm

So, we should construct empty lake having an area of 10 km x 5 km which can retain 3.00 m height of water or 4 km x 3 km area which can retain 12.5 m height of water. The area selected is between Mandvi upstream and Kakrapar downstream, between the left and right canals of Kakrapar. This empty lake will allow river water to flow normally throughout the year. Whenever the flowing water needs to be controlled, the gates of the underflow weir, provided at the lower part of the lake, is closed, so that water is retained between the lake and Kakrapar dam. Water can be stored in this empty lake to prevent flooding of the city during monsoons and/or for utility purposes. To construct this lake, the proposed area is excavated upto 20 mt, uptill the river bed and the excavated earth is used to construct the earthen wall on the boundary of the lake.

The capacity of the proposed empty lake is

4 km x 3 km x 20 m

= 240 mcm.

This capacity is 1.6 times more than the quantity of water flooding Surat on 8th August, 2006. An underflow weir for this empty lake is provided near Mandvi. When rainfall is heavy and sea water near Hope Pool, Surat, reaches the danger mark, the underflow weir at the end of the empty lake is closed, due to which water discharged from the dam starts filling the empty

lake. This way, water is restricted from entering Surat city, preventing floods in the city and nearby areas. This water can be stored for many days, till the water volume downstream decreases following which the stored water is released gradually so that it can flow into the sea.

Similar empty lakes can be constructed at Bhairav and Bodhan so that more volume of water can be stored to manage critical situations during floods as well as to store water for utility purposes throughout the year, specially during deficiency of rainfall. For these utility purposes, additional water works can be developed near these emergency empty lakes.

Moreover box tunnels constructed in lieu of embankments, will facilitate water supply upto newly developed areas upto ONGC bridge. Roads on top of these box tunnels can help transportation from ONGC bridge upto NH8 at Kathor which will ease the traffic inside the Surat city.

As mentioned in the example above, similar constructions can be made on the river Narmada, in and near Bharuch city between Sardar Sarovar Dam which is the main dam uptill Dahej, where the mini dam can be constructed.

Similarly in Kerala, on the river Periyar, similar constructions of the present invention can be made in downstream of the Cheruthoni Dam in the Idukki district, till the Lower Periyar dam upto the powerstation and mini dam near Kochi airport.

The present invention proves to be highly advantageous to protect cities and villages throughout the world, due to flooding in the river flowing nearby or due to high tides in the sea. It also protects the cities and villages from drought conditions by storing the river water for utility purposes. Dredging of the river increases the water holding capacity of the river and decreases its salinity.

Multipurpose box tunnels over the mini dam constructed near the tail of the river, prevents the entry of saline water from the sea, even during high tide, into the river or nearby cities and villages, ensuring the potability and utility of the river water and ground water in nearby areas. The mini dam prevents erosion as well as assists in storage of river water for further use. When the river is flowing heavily, the gates of the multipurpose box tunnels in the mini dam can be opened for discharging the water into the sea, thereby preventing floods. Roads can be built on these multipurpose box tunnels which increase the connectivity within and outside the cities and villages and reduce traffic problems.

Emergency empty lakes along with overflow and underflow weirs, of the present invention, assist in storing excess water of the flooding river which can't be dischared into the sea due to high tide and thereby prevent flooding of cities and villages lying on the banks of the river. The stored water can be dispensed in the river later or can be used for utility purposes in future.

The embankments of the present invention provide safety to all the villages and cities lying on the banks of the river, from being flooded due to overflow of the river or due to creeks formed. Roads constructed on the surfaces of these embankments increase the connectivity within and between various cities and villages lying on the banks of the rivers. The RCC boxes used for the construction of these embankments can be used for storing water from the river for utility purposes. Similar RCC boxes nearer to the river can be used for emptying the drainage obtained from the cities and villages which can be piped out directly into the sea thereby protecting the river from being polluted due to drainage.

Thus the present invention is highly advantageous as it protects the cities and villages from floods, droughts, pollution of rivers, salinity of ground water and increases connectivity within and between different cities and villages lying on the banks of the rivers.

Although the preferred embodiment as well as the construction and use have been specifically described, it should be understood that variations in the preferred embodiment could be achieved by a person skilled in the art without departing from the spirit of the invention. The invention has been described with reference to specific embodiment which is merely illustrative and not intended to limit the scope of the invention as defined in the claims.

I claim,

1. Integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control in river, to protect cities, villages, airport and other places, located near banks of river, having a major dam (D_1) upstream and sea (S) downstream,

wherein, the multipurpose RCC box tunnels (T), are built on top of a mini dam (D_2) constructed across the river, near the tail of the river (R) near the sea, discharging flood water, into the sea (S) at a height, which is greater than the highest tide level (HHTL) in the sea, so that sea water can't enter the river path, while, flood water from river can flow into the sea, without interruption, even during highest tide level;

wherein multipurpose RCC box tunnels (T), are open on both ends, without gates, and are built, having openings along the line of river flow, on the top of mini dam (D_2);

wherein the mini dam (D_2) is constructed using the materials excavated from the river bed during the dredging of the river, to increase its water carrying capacity and has a height greater than the highest tide level of the sea;

wherein to release water from riverside into the sea at height lower than highest tide level (HHTL), level control box tunnels (T_1), with gates (G) are provided, between the (HHTL) and the normal high tide level (H_1) of the sea;

wherein the gates (G) of (T_1) open only towards the sea (S) due to hydraulic pressure of water from riverside and allow water from the river to flow into the sea, while the sea water cannot enter the river path due to the presence of shock absorber system (Sa) which is placed at such a level as to prevent any movement of gate, to open on river side;

wherein the gates (G) are normally kept closed vertically and are locked by pressure of the sleeping locking plate from sea side on the gates (G);

wherein emergency empty lakes (EEL) are constructed on the river (R) between the downstream of major dam (D_1) and upstream of the city and villages, intended to be protected from flood;

wherein the emergency empty lakes (EEL) are constructed on the river (R) by excavating the side banks of the river, up to the river bed, in areas having less population and cheap land to construct a huge lake having a water holding capacity, greater than the amount of water which can flood an entire city or similar areas;.

wherein the emergency empty lakes (EEL) are provided with an overflow weir (W_1) upstream at its starting point and an underflow weir (W_2) downstream at its end;

wherein the river water coming in emergency lake (EEL) from upstream, can flow down normally through the lake, downstream in the river (R) when gates of underflow weir (W_2) are open (GO);

wherein during emergency, when water discharged from major dam (D_1) reaches danger mark, and at the same time when there is high tide in the sea, the water released from the dam (D_1) can flood the nearby city and similar areas, to prevent this, all the gates of underflow weir (W_2), provided at its lower part, are closed (GC) following which water stops flowing downstream of the emergency empty lake (EEL) due to which the emergency empty lake (EEL) gets filled by this excess flood water discharged from major dam (D_1) thereby protecting the city and other areas from flooding;

wherein embankments made of multipurpose box tunnels (Te), are constructed on both sides along the banks of the river, from upstream of area intended to be protected from flood, upto the downstream dam (D_2), to prevent flood water of the river, from

overflowing the banks or seeping in through the low level creeks into nearby cities and villages;

wherein the multipurpose box tunnels (Te) built as embankments have ends closed and have low partitions across, at required lengths, to store utility water in them, for supply to nearby cities and villages;

wherein the multipurpose box tunnels (Te) have roads built on their top surface connecting various areas, along the banks of river, thereby increasing connectivity and solving traffic congestion within the city;

wherein, small RCC box tunnels (D), are placed, between the multipurpose box tunnels (Te) and the banks of river, which are used to collect drainage from the city and village and discharge it into the sea directly beyond mini dam (D_2).

2. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 1 wherein the mini dam (D_2) is constructed 1 to 2 kms away from the sea, inside the river, having width, wider than the average width of the river, across the river to allow maximum possible discharge of the river flood water into the sea.

3. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 2 wherein the mini dam (D2) has a height of 0.5 meters above the highest tide level (HHTL) such that the sea water cannot enter the river even at the highest tide level ever.

4. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 1 wherein the multipurpose box tunnels (T) built on the top surface of the mini dam (D_2) are made of RCC and have openings in them for the

river water to flow down in the sea wherein the openings are designed in the shape of Ventury tube (V) from inside which allows the enhanced flow of water from the river into the sea.

5. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 3 wherein roads (Rd) connecting both the sides of the river are built on the top surface of the multipurpose box tunnels (T) thereby increasing connectivity of areas on both banks of the river.

6. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 1 wherein additional level control box tunnels (T_1) with gates (G) are built in the central part of the mini dam (D_2) through only 30% to 40% length of the mini dam (D_2), between the highest tide level (HHTL) and the normal high tide level (H_1) wherein the gates (G) are dropped down vertically from the axle (A_1) and (A_2), mounted at the top of the box tunnel and have swivel movement with shock absorbers (Sa), fitted near the bottom of gates, inside the box tunnel, on river side of the gate, which absorbs the shock when the gate is dropped down to close, preventing damage to its structure and also prevents movement of gate (G) towards the river side thereby preventing the entry of sea water in the river path.

7. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 6 wherein the gates (G) of the level control box tunnels (T_1) in the central part of the dam, are normally kept in closed (C) position by the locking plate system (L). wherein, when water is to be released from the river (R) from the upstream of dam (D2) into the sea, when low tide level (LTL) is in the sea, the mechanical locking system of the gate is released to open (O) them with the help of chain

linked with the driving motor (D) following which the pressure of water flowing in the river pushes open the gates and opens them upto 80^0 on sea side, facilitating the flow of water from the river into the sea, wherein when the flow of the water in the river is normalized, the pressure exerted by the river water decreases, following which due to self weight of the gates, they are closed automatically in vertical position and are locked automatically, due to the angular pressure of the locking plate from the sea side.

8. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 1 wherein the overflow weir (W_1) present upstream at the start of the emergency empty lakes (EEL), allows water of the river (R) to flow over the weir and pass into the emergency empty lake (EEL) wherein during normal flow of the river, water passes through the lake and from below the underflow weir (W_2) through its open gates (GO) further in the river (R) wherein during flood, when huge volume of water is released from the major dam (D_1) and all the water can't flow down into the sea due to flood and high tide in the sea, the gates of the underflow weir (W_2) are closed (GC) due to which the water which enters the emergency empty lake (EEL) by flowing over the overflow weir (W_1), gets stored in the emergency empty lake (EEL) until the flood and high tide condition in the sea decreases, following which water from the lake is gradually released by partially opening the gates of the underflow weir (W_2), such that it flows downstream in the river and gets discharged in the sea, through multipurpose box tunnels (T) constructed on mini dam(D_2).

9. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 8 wherein the capacity of the emergency empty lakes (EEL) is designed to be almost 50% more than the maximum estimated quantity of water

which can be discharged from the upstream dam (D_1) which can flood the areas to be protected.

10. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 1 wherein the emergency empty lakes (EEL) can also be used to store water up to 70% of its capacity throughout the year after the end of current monsoon season such that the stored water can be used for utility purposes and can be helpful in drought conditions which can later be emptied before the start of the next monsoon season.

11. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 9 wherein the underflow weir (W_2) is made of RCC and roads (Rd) are built on the surface of the underflow weir (W_2), connecting both the sides of the river.

12. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 1, wherein the embankments on both the sides of the river comprises of multipurpose box tunnels (Te) constructed on required foundation along the banks of the river (R), right from the main upstream end of the city, upto the mini dam (D_2) perpendicular to the width of the river (SS_1) wherein the height of these box tunnels will be higher than the historical highest flood level, such that nearby cities and villages are protected from flooding.

13. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 12 wherein roads (Rd) are built on the surface of these multipurpose box tunnels (Te) which increases the connectivity between cities and villages.

14. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in 12 wherein the multipurpose box tunnels (Te) comprising the embankment are closed at ends and are used to store large volumes of water which can be used for utility purposes of nearby cities and villages, thereby reducing the capital cost.

15. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control as claimed in claim 1 wherein small RCC drain box tunnels (D) ,which are closed from all four sides and are constructed parallel to the embankment tunnel (Te) between the bank of river (R) and the main multipurpose box tunnel (Te) wherein all the drainage pipe lines of the nearby cities and villages are connected to the drain box tunnel (D) which discharges the drainage through these drain box tunnels (D),all along the river (R) directly into the sea (S) beyond mini dam (D_2) thereby preventing pollution of river.

16. The integration of multipurpose box tunnels with empty lakes and mini dam for effective flood control substantially described with reference to the foregoing description and drawings.

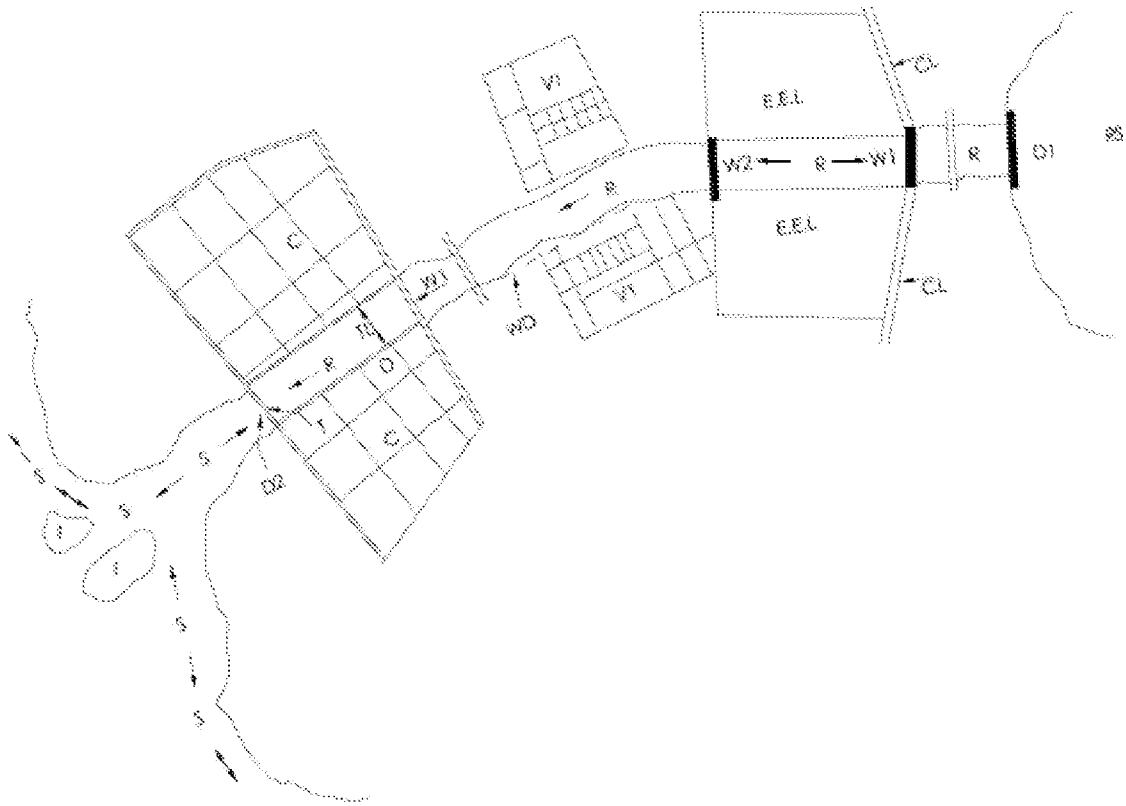

Fig. 1

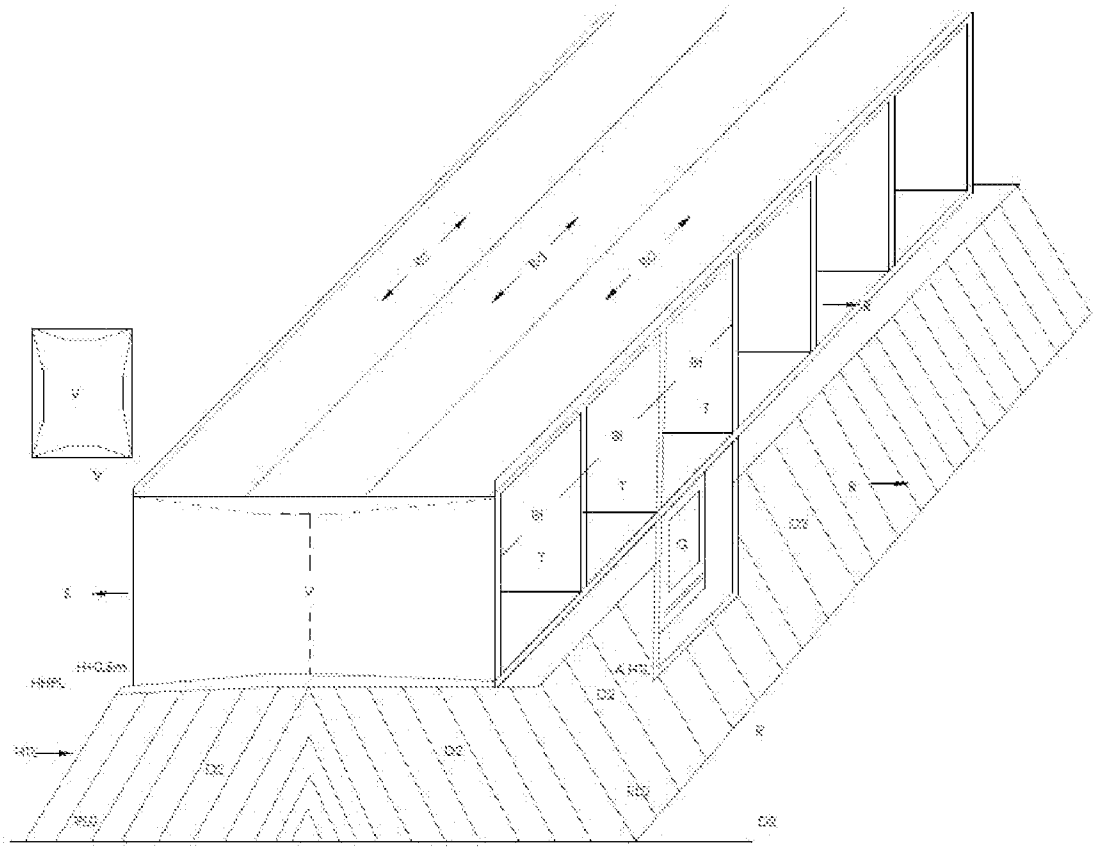

Fig. 2

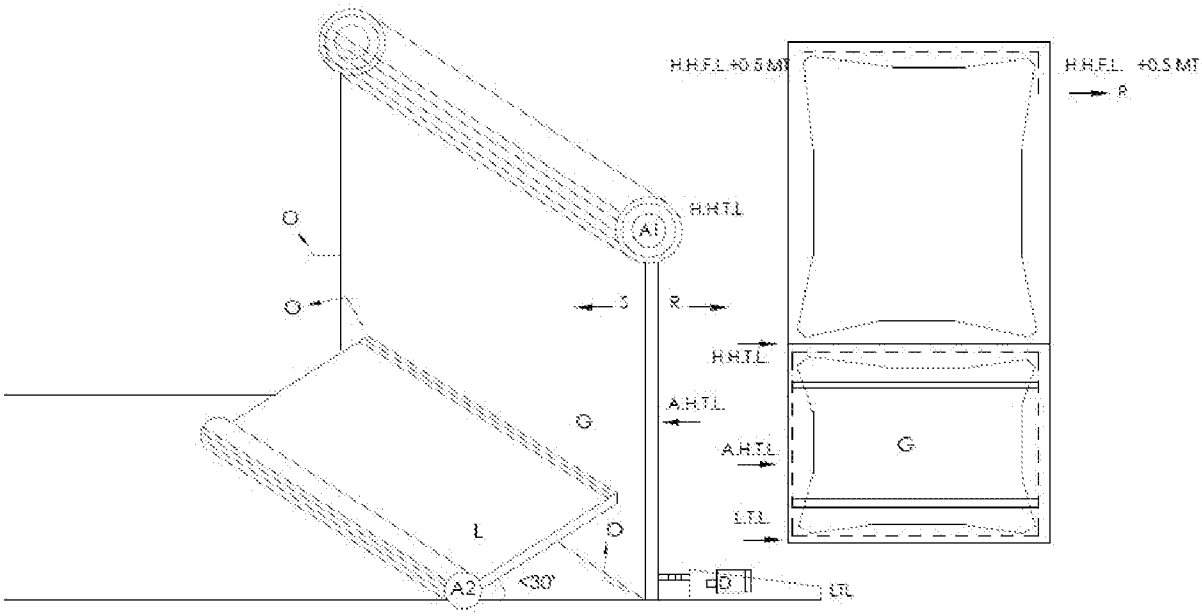
H.H.F.L +0.5 MT
H.H.F.L +0.5 MT
A1
H.H.T.L
O
O
S
R
H.H.T.L
A.H.T.L
A.H.T.L
G
G
L
O
A2
<30°
D
L.T.L

Fig. 3

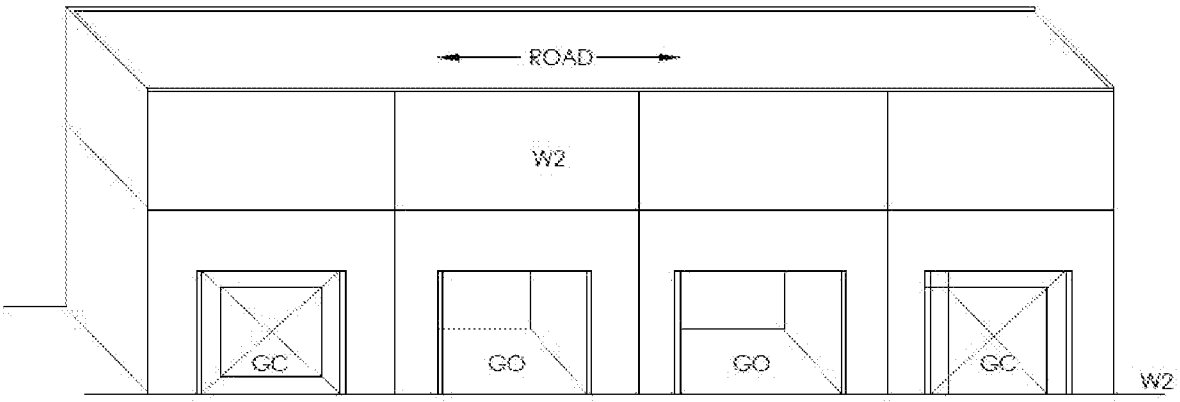

Fig. 4

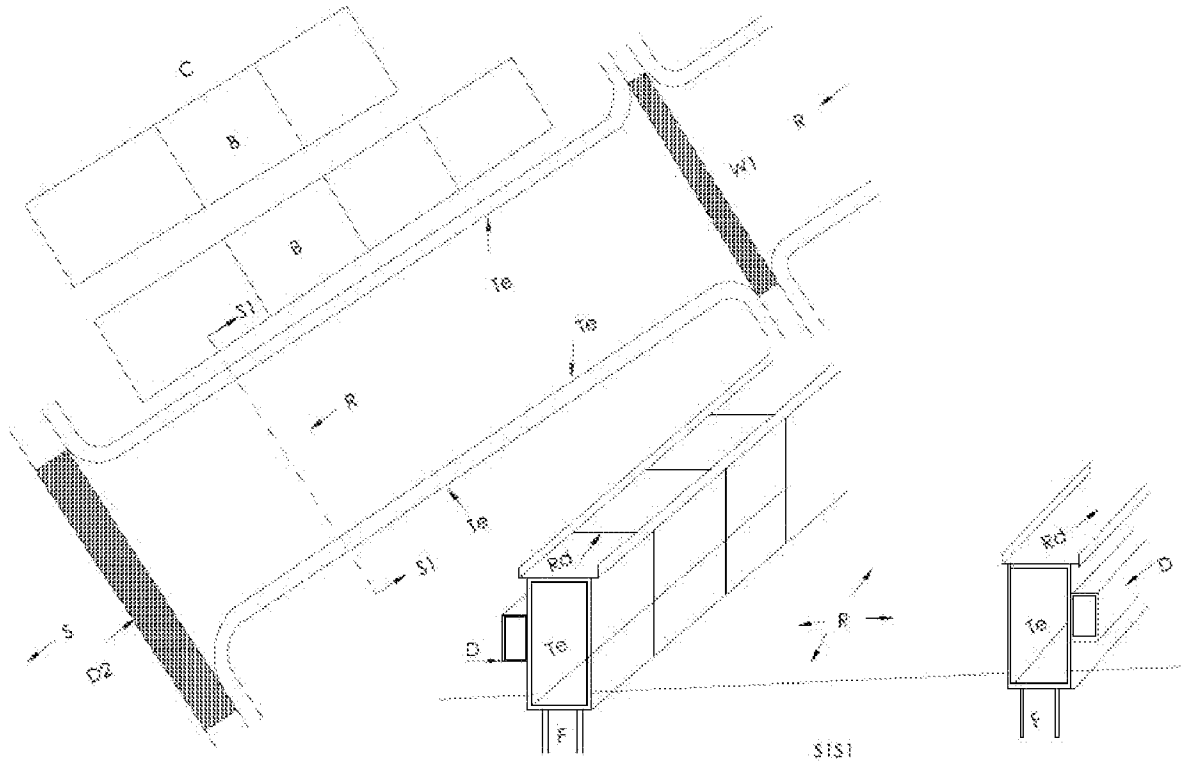

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2018/050690

A. CLASSIFICATION OF SUBJECT MATTER
E02B3/04 Version=2018.01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

TotalPatent One, IPO Internal Database and Google Patent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN105951968 (A) (CHINA ENFI ENG CORP) 21 Sep 2016 Claim 1, Figure 1 and Description paragraph [0024] and [0026].	1-16
Y	JPH10298962A (A) (JAPAN ATOM POWER CO LTD,THE MAEDA CORP) 10 Nov 1998 Abstract	1-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10-12-2018	10-12-2018
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Authorized officer Prince Lal Telephone No. +91-1125300200