Polavaram Project Right Main Canal Package-III

The 30.712 km long package 3 of the Polavaram Right Main Canal, part of National River linking project

Background

Polavaram Project is a multi-purpose irrigation project and a part of the National River-Linking Project, undertaken by the Indian Ministry of Water Resources, to overcome the water deficit in the country. Under this plan, around 30 river-links aggregating a total length of 14,900 km will be built to divert the surplus river water to the water deficit areas.

In case of Polavaram project, the Godavari river basin is considered as a surplus one, while the Krishna River basin is considered to be a deficit one. Around 644 TMC of under utilised water from Godavari River flows into the Bay of Bengal. Based on the estimated water requirements in 2025, the Study recommended that sizeable surplus water be transferred from the Godavari River basin to the Krishna River basin.

The central part of the Polavaram project is the barrage constructed across the Godavari River around 15 km north of Rajmundhry in East Godavari district. This barrage will generate electricity and also feed water to the left and right bank canals.

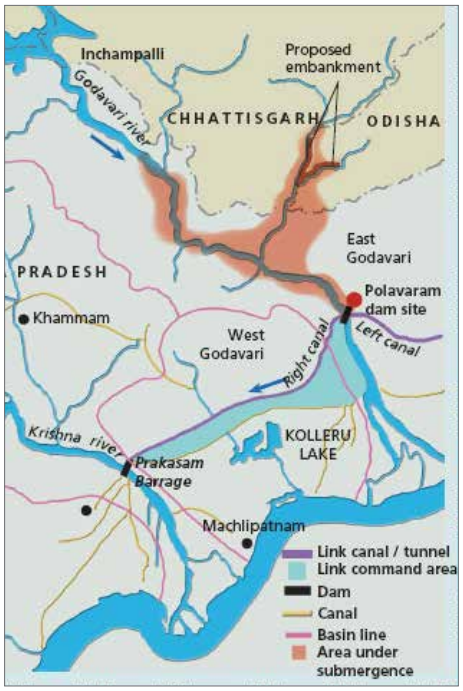
The left main canal is designed to provide water to 12 lakh acres in north coastal districts of Andhra Pradesh besides meeting the drinking water needs of urban and rural areas. It will connect with Yeleru Left Main canal to supply water for industrial (Vizag steel plant) and drinking water purposes. It will also supply coastal Andhra Pradesh with irrigation water in Vishakapatnam, Vizianagaram and Srikakulam districts.

The 174 km long right main canal is designed to supply 80 TMC of water from Polavaram to Budameru in Vijayawada, connecting Godavari and Krishna rivers. The objective of the right canal is to irrigate an area of 129259 Ha (319400 Acres) in the upland area of West Godavari and Krishna districts. Based on its water carrying capacity, the canal is designed with a canal bed width of 77.25 meters and is one of the large width canals in India. Due to its large width, it is proposed to be used for freight navigation in future.

The right main canal construction work is divided in 7 packages. The construction of 30.712 km long Package-3 of the right main canal was awarded to HCC as an EPC turnkey contract.

Project details

HCC's scope of work included conducting detailed investigation including subsoil exploration, preparation of hydraulic particulars, design and construction of cross masonry and cross drainage (CM&CD) works, fixing benchmark stones along main canal, preparation of detailed estimate, preparation land plan schedules,

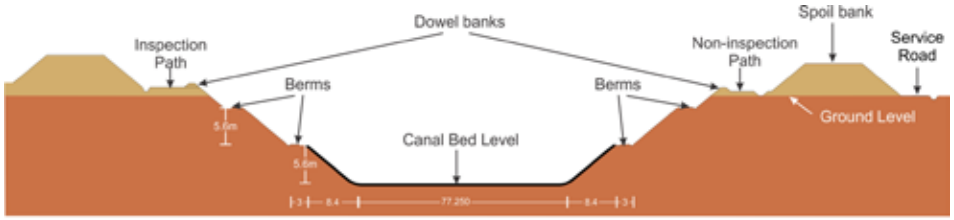


excavation of main canal and canal lining, plantation along the main canal, formation of service roads on left bank of main canal.

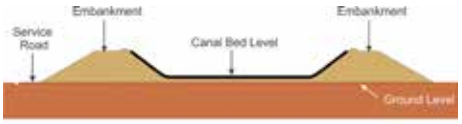
Client	Irrigation and CAD Dept. Govt. of Andhra Pradesh
Contract Value	Rs. 321.3 Crs
Type of Project	EPC

Methodology

The work mainly consisted of large scale excavation/earth work, lining of the canal and construction of various structures such as bridges, underpasses, siphons, off take sluice and off take regulator. A total number of 38 structures are built along the alignment of the canal. Out of the total 30.712 Km length of canal, work was started in the initial 7.3 Km and the last 4 Km as per the availability of the land from the client. Total work was divided into 6 zones and the zones were further divided into sub-zones to ensure continuous work front for lining, minimum travel distance for disposal and mobilization capacity of the subcontractors.



Cross Section in Deepcutting



Cross Section in Bank Filling

Earthwork: In an uneven topography along the alignment of the canal, the canal section was excavated to the profile as per typical sections (shown in diagram), where the ground level was above the canal bed levels and in certain sections where the ground level was below the canal bed level bank fillings were done with the use of excavated material.

While excavating, both edges of the bank were neatly aligned symmetrically to the canal centerline. The edges are absolutely straight in reaches and smoothly curved in bends. Berms (fortification) of 3 m widths are provided at every 5.6m of depth depending upon the total depth of excavation. Clearing, grubbing and surface stripping was done up to 30 cm above the Canal Bed Level (CBL). Similarly berm wise excavation was also done till 30 cm.

The embankment construction mainly consists of formation of embankment of homogenous section with materials obtained from excavation, trimming of side slopes, formation of approach ramps, formation of dowel banks, green covering of slopes and construction of surface drains. The embankment work was done from Km. 38.199 to 40.200 and Km 65.200 to 67.200.

Structures: The structure work across the canal was taken up after completion of the canal excavation works. The structure work mainly consists of construction of foundation, substructure and superstructure. Total eight types of structures were provided all along the alignment of the canal depending upon the type of crossing encountered.

- For village road crossings single lane bridges were constructed and for state highway crossing double lane bridges were provided. For superstructure of bridges, precast girders with precast panels were used to save the time and cost.
- The Super passages were provided where the canal bed level is far below the natural crossing stream/nullah. For super passages U shaped troughs were provided. The number and size of the troughs was designed based on the quantity of the discharge at particular locations.
- The Under Tunnels were constructed for crossing the existing stream whose bed level is well below the canal bed level. For under tunnels, barrels of different sizes and numbers were provided based on the required discharge capacity.
- The well siphon and siphon were constructed where both super passage and under tunnels are not feasible i.e. there is nominal difference in canal bed level and natural crossing stream level. The well siphon was constructed for crossing of natural stream

Hydraulic Parameters

Sr.	Description	Reach From Km.38.199 to Km.56.600	Reach From Km.56.600 to Km.68.611	Reach From Km.68.611 to Km.68.911
1	Discharge Required	390.343 Cumecs	376.803 Cumecs	367.553 Cumecs
2	Discharge Designed	391.130 Cumecs	378.110 Cumecs	368.820 Cumecs
3	Bed Width	77.25 m	77.50 m	78.50 m
4	Full Supply Depth	4.60 m	4.50 m	4.40 m
5	Bed Fall	1/20000	1/20000	1/20000
6	Velocity	1.010 m/s	0.997 m/s	0.985 m/s
7	Value of 'n'	0.018	0.018	0.018
8	Side Slope	1.5:1	1.5:1	1.5:1
9	Bed Level	+32.888/+31.628	+31.603/+30.912	+30.812/+30.797
10	F.S.L	+37.488/+36.228	+36.103/+35.412	+35.212+/+35.197
11	T.B.L	+38.488/+37.228	+37.103/+36.412	+36.212/+36.197

below the canal whereas siphon was constructed for crossing of canal below the natural stream level

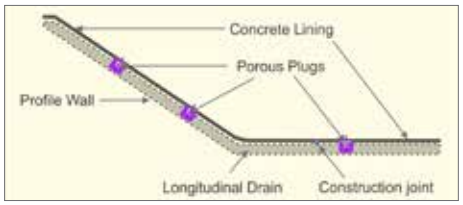
- Off take regulator is a gated structure constructed across the canal to control the canal flow and to carry out maintenance operations
- The off take sluices are also gated structures and were provided on left side of the canal to supply water to the distributaries for irrigation

Major Structures (Total 38 Nos)

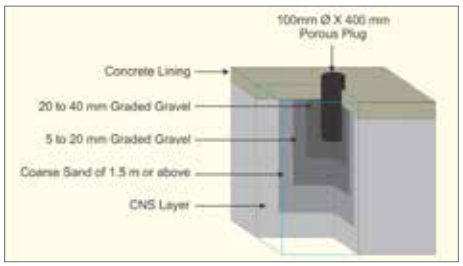
Single Lane Bridges	11 Nos
Double Lane Bridges	06 Nos
Super Passages	05 Nos
SP cum SLRB	01 No
Under Tunnels	06 Nos
Well Siphon	01 No
Siphon	01 No
Off take Sluice	05 Nos
Off take regulator	02 Nos

Canal Lining: For canal lining purpose, first profile walls of 200 mm x 150 mm dimensions are constructed across the width of the canal to the desired level of sub grade. These walls are used as guidelines for the concrete pavers for laying the final concrete lining.

After preparation of the profile walls, the sub grade preparation is taken up by manually smoothening the surface between two profile walls to the desired level on which the final concrete is laid. These walls are placed at spacing of 10m interval in curve portion and 20m interval in straight portion in canal flow direction.



Cross sectional diagram of canal lining



Longitudinal and traversed porus plug installed along the concrete lining.

Canal lining of a thickness of 100mm with M10 grade concrete is then carried out over a prepared sub grade in two stages. First for the slopes and then for the bed of the canal. The sequence of lining is kept as Slope lining first and then Bed lining, as the material collected during the slope preparation at the bottom will have to be disposed off from the bed for which movement of vehicles is required. Then the bed lining follows in the canal flow direction in alternate patches of concreting.

Before undertaking the canal concrete lining, drainage arrangements such as porous plugs, longitudinal and cross drainage system and pressure relief valves in the bed and slopes are provided depending upon the soil condition in the particular stretches. These drainage systems relieve ground water pressure especially in the monsoon season from breaking the canal lining by systematically distributing ground water pressure and channelizing the ground water flow in the canal.

Miscellaneous works: For communication purpose an inspection path of 3m width on the right hand side and service road of 5m width on the left hand side were provided all along the canal alignment. Longitudinal catch drains were provided along the roads and on the outer side of the spoil banks for the ease of rain water drainage.

Also Dowel banks were provided on both sides of the canal edges to avoid rain cuts and to protect the concrete canal lining. From an environmental aspect plantation was carried out on both side of the canal along the right of way (ROW) at 10m interval. Around 6000 saplings were planted of local variety.

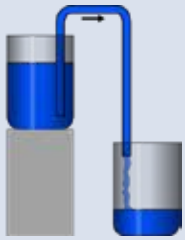
Challenges encountered during construction:

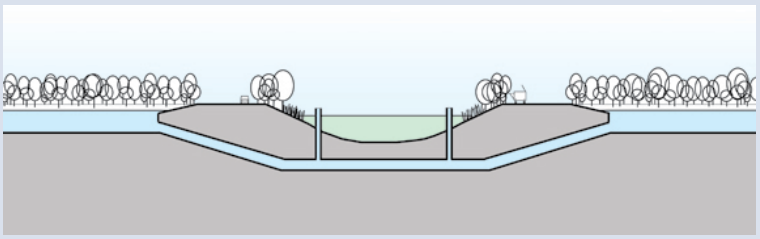
Construction of a major Siphon structure

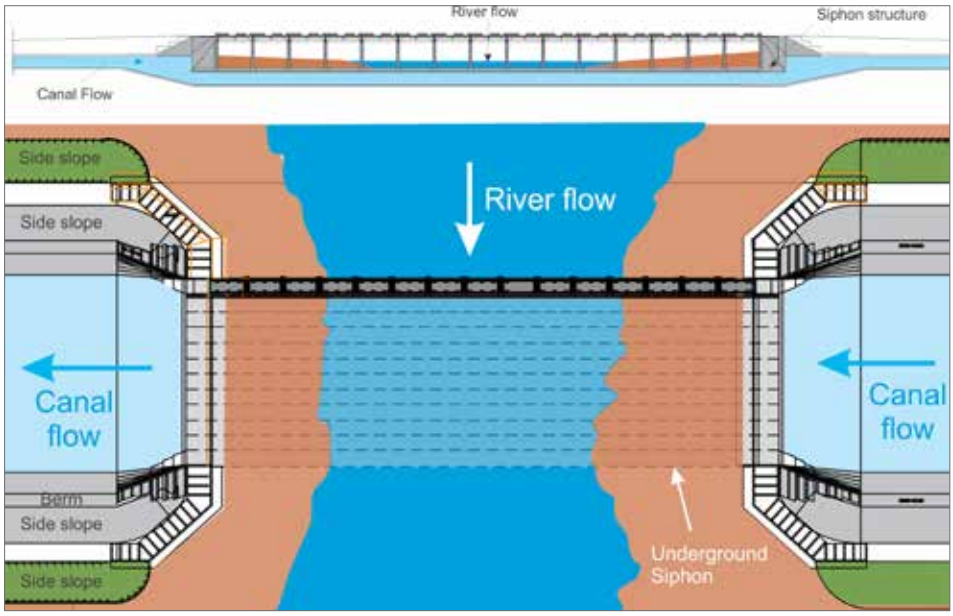
The right main canal was crossing a perennial natural stream called Errakalva at Km. 50.140 having maximum flood discharge of 4375 cumecs and catchment area of 1960 Sqkm. The deep bed level of the stream was 31.051m as against Canal Bed Level (CBL) of 32.209m. Therefore canal siphon was proposed for this location.

What is Siphon?

The word siphon refers specifically to a tube in an inverted U shape which causes a liquid to flow uphill, above the surface of the reservoir, without pumps, powered by the fall of the liquid as it flows down the tube under the pull of gravity, and is discharged at a level lower than the surface of the reservoir whence it came. In canals, siphons structures are built for transferring water above or below an obstacle such as a river or road crossing the canal.







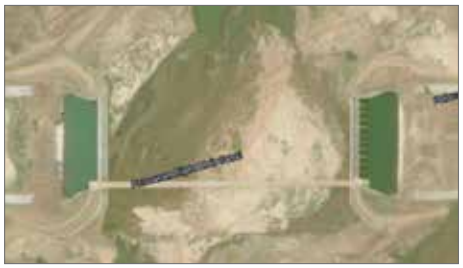
It is one of the massive structures of the project, designed to carry 391.130 Cumecs of canal discharge. It is an RCC barrel structure with 12 vents of each 5.50m x 4.25m clear opening in RCC M30 grade concrete with slab thickness of 650mm at top and bottom, outer vertical walls of thickness of 650mm and inner walls of 400mm. The total length of the structure is 221.60m excluding transitions. Including transition the total length of the structure is 280.60m. The counter fort retaining walls were provided in RCC M30 grade on all four sides of the structure. The quantity of work involved concrete of 58,490 Cum, Reinforcement steel of 5470 MT and Shuttering of 97,075 Sqm. (It is approximately 35% of the total project structure quantity).

Before starting of the foundation excavation work, the existing stream was diverted suitably considering the maximum expected discharge with the formation of the temporary channel. The construction work of this giant structure was started on 11.11.2009 and was successfully completed on 28.06.2011 with meticulous planning and strong efforts of the project team. Client has also appreciated HCC, for the completion of such structure with good quality and safety measurers.

Excavation and lining works in Deep Cut reaches

As per the approved R4 alignment of the project the deep cut reach is from Km. 43.750 to Km 46.000, from Km 47.500 to Km 48.500 and from Km 56.000 to Km 63.500. The depth of cutting involved in this reach ranges from minimum 10m to maximum 21m. As per the approved section berms of 3.0m widths at every 5.0m of the depth of excavation were provided. The total executed quantity of the earthwork excavation is 1.36 Crores Cum.

Deep Cut reaches at the Polavaram Canal yes



Google image of Siphon under construction

The most critical activity in this reaches was the laying of canal concrete lining. It was carried out with the help of concrete chute frame designed to pour the concrete in slope paver hopper. In area having depth of cut more than 17.0m berm width was increased up to 6m to facilitate fixing of concrete frame and movement of transit mixers on this berm. Appropriate ramps were provided for smooth entry and exit of the transit mixers. All the required safety measurers were ensured.

Highlights of safety measures

For the single lane and double lane bridges, total 543 pre-cast girders were casted at centrally located casting yard where Gantry Crane of 25 ton capacity were provided for the movement of shuttering and other heavy material, girder shifting and stacking.

For shifting of pre-cast girders from casting yard to site location, special lifting beams were designed and maintained to lift the girder, with the help of Gantry Crane, from stack yard to 30 ton flat bed trailer.

Girder launching operation was one of the riskiest tasks. During the execution of these works utmost safety precautions were taken at all stages like; planning, transporting segments, fabrication and erection of launching girders. This work was completed without a single reportable incident and without losing a single man-hour due to injury.

A safe lockout and tagging procedure was followed while working on or near electrical systems, machinery, pressure systems, and rotating equipment.

This project also involved working on heights of more than 6.0 meters. Complete safety measure were adopted like using of stable and secured platforms, railings for edge protection, individual fall arrest systems like safety harness and workers were trained for maintaining

healthy and safe working postures. Medical test were also conducted for the workers working at such heights.

A number of safety motivational and training programs were conducted for all the workers and continual improvement of the safety culture was executed which led to enhanced safety performance and efficiency benefits. 7.59 million safe man hours was achieved during the execution of this project.

Major Project Quantities

Length of the canal	30.712 KM
Earth work	2,31,18,818 Cum
CM&CD Concrete	1,68,670 Cum
Canal Lining with CC M10	3,13,091 Cum
Reinforcement Steel	10506 MT
Structural Steel	244 MT

Impact of the project on general public

This project will irrigate 1.29 Lac Hectares of agricultural land in the upland area of West Godavari and Krishna District. This canal also diverts 80 TMC of water from Godavari River to the Krishna River on upstream of Prakasham barrage which will meet the irrigation requirements of Krishna Delta partly, thus fulfilling the demand deficiency of Krishna River.

It will increase the agricultural production and economic status of the farmers and generate employment potential due to development of Agro based industries.

DID YOU KNOW ?

Which is India's Longest Canal?

The Indira Gandhi Canal is the longest canal in India and the largest irrigation project in the world. This Canal is 649 km long and consists of Rajasthan feeder canal and Rajasthan main canal. It runs through 167 km in Punjab and Haryana and remaining 492 km in Rajasthan. It starts from the Harike Barrage at Sultanpur in Himachal and enters into Haryana via Punjab and then enters into Rajasthan near Kharakhera village of Rajasthan. It then further traverses through seven districts of Rajasthan like Barmer, Bikaner, Churu, Hanumangarh, Jaisalmer, Jodhpur and Sriganganagar.

The canal is among the greatest civil engineering feats in the world and was built with an objective to convert the Great Thar desert in Rajasthan from a wasteland to an agriculturally productive area.

The idea of bringing the waters from the Himalayan rivers flowing through Punjab and into Pakistan was conceived by an hydraulic engineer Kanwar Sain in the late 194Os, soon after India became independent. He proposed that 2 million hectares of desert land in Bikaner and the northwest comer of Jaisalmer could be brought under irrigation from the stored waters of the Punjab rivers. Soon thereafter, a feasibility study was conducted by the Central Water Commission, a government body in charge of water survey and allocation. In its brief report, the Central Water Commission spelled out the necessity of building a canal through the western Rajasthan desert which will provide new habitation over 2 million hectares. As per an interstate agreement reached earlier in 1955 between the states of Punjab and Rajasthan, the latter was allocated 8 million acre-feet of water. The proposed Rajasthan Canal envisaged use of 7.6 million acre-feet of water. Finally the construction work on this project began in the year 1958.

From the start, the project ran into difficulties. Under the leadership of India's first Prime Minister, Jawaharlal Nehru, a grand plan to build basic infrastructures and heavy-engineering facilities had already been undertaken, albeit with extremely limited financial resources. The canal was not abandoned, but a shifting of resources destined for its construction slowed its progress. In 1983, Stage I was finally completed, 20 years behind schedule. As of now, the Stage II main canal and over 50% of its distributory system have been completed.

The total length of the canal system, from its head works in Punjab to the tail end at Gadra Road, is 9,425 km-almost twice the combined length and breadth of India. If stored in the form of a pyramid with a 1,200-foot (364.7 m) square base, the earthwork done for the canal would be higher than Mount Everest (29,000 ft./8.82 km). Some 3.4 billion concrete tiles were used to line the canal, which would be enough to encircle the earth along the equator with a two lane highway, with each lane 12 feet wide.

The Indira Gandhi Canal has the possibility of bringing the success of the Imperial Valley to this region of India, opening up a whole new area for full economic development.