MERAWA DAM AND MICRO HPP, SUSTAINABLE DEVELOPMENT IN IRAQ

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Abstract: *The location of the Merawa dam is situated on the Cham I Daraban River, tributary of Qala Chuwalan River, which in its turn is tributary of the Lesser Zab River. From the administrative point of view, the dam site is located in Suleimaniyah Governorate, Sharbazer District, Iraq. The proposed works consist of a 38.50 meters high Dam and HPP which aims to provide a sturdy reserve of water for hydropower, irrigation and water supply for the residential areas in the downstream. Electric power is very important for the development of the area, as this war troubled zone laks entierely electricity, moreover it is considered to be a strategic area as the Iran-Iraq border is nearby. The Dam and micro-HPP will be able to provide the area with base energy, with a sturdiness granted by the volume of the reservoir, as now the only power sources are isolated fossil-fueled generators. The energy produced by the 150 kW turbines might seem small, but the community will be able to rely on this source as it's primary supplier.*

Keywords: DAM, RIVER, PRODUCE ENERGY, IRRIGATION, WATER SUPPLY

1. Introduction

Water resources management in Kurdistan aims primarely to satisfy water demands , thus the best locations for hydrotechnical structures that are able to collect excess rainfall and flood water have been analyzed, as the regions are, now, mostly dependent on underground water, with little or no storage capacity. A great importance is given by the Government of Kurdistan Region (KRG) for developing the Dam projects in order to transform the dry lands into perennial green fields, that subsequenlty also produce electricity for the local community and national power grid. Such a project is Merawa Dam.

2. Location

The location of the Merawa dam is situated on the Cham I Daraban River, tributary of Qala Chuwalan River, which in its turn is tributary of the Lesser Zab River.

From the administrative point of view, the dam site is located in Suleimaniyah Governorate, Sharbazer District. The proposed works consist in a dam on the river course which aims to provide water for electricity producion, irrigation and to supply with water the residential areas, in a harsh climatic area.

3. Description of works

The hydrographical basin surface of the Cham I Daraban River in the Merawa storage reservoir section is of 48.03 km^2.

According to the survey made in the "Kurdistan Region Water Infrastructure Sector Master Plan" study prepared by SETEC Company in 2011, the Merawa River basin receives an influx specific flow to 8.3 l/sec/km^2.

The dam site is located approximately at 1230 m downstream of the existing bridge that is the main and only acces point in Merawa village.

The dam crest was calculated in such matter that the tail reservoir water will not engage the bridge on the pressure even for maximum flood of 1:10 000 return period.

Minding the conditions mentioned above, the water storage volume at Normal Water Level (NWL) is 1.853.676 m^3 from which the life storage 1.454.124 m^3.

The main components of the hydrotechnical works are:

- The dam of 38.50 m elevation, crest length of 250 m, rockfill dam type;
- The normal water level is 1201 m.a.s.l,;
- The level of crown is 1205 m.a.s.l.;
- The spillway with side admission, placed on the right bank;
- The bottom outlet, situated within the dam body, in the gallery that is initially used as water diversion during the execution of the works.

The cross section of the dam body is trapezoidal shaped with the crest width of 6.00 m, upstream slope of 1:1.75, downstream slope 1:1.75 with 2 berms of 3.00 m width, maximum height from foundation is 38.50 m thus ensuring all the characteristics needed to consider Merawa dam is in the Large dam cathegory. Merawa dam is designed as a Concrete Face Rockfill Dam. The inclination of the slopes is a result of the stability calculation taking into consideration the earthquake action. The first two layers represent the support layer for the reinforced concrete facing of dam. In the dam body it was provided a material zoning, as follow (fig. 4):

- Zone 1 – maximum 96 mm rockfill layer
- Zone 2 – maximum 250 mm rockfill layer
- Zone 3 - maximum 500 mm rockfill layer

The bottom outlet assembly works are placed in the central part of the dam body and has the following components:

- The intake tower
- The gallery

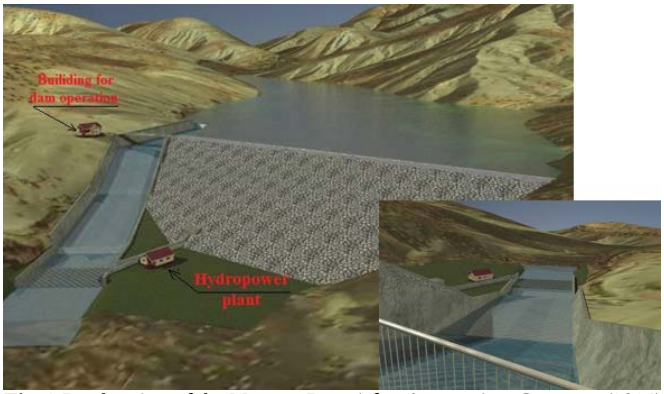

Fig. 2 *Render view of the Merawa Dam (after Aquaproiect Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governate / Mawat district.)*

The foundation sealing will be accomplished using a grout curtain by injecting pressurized cement grout, through two rows of injections, from vertically borehole-drillings posed at an inter-axial distance of 1.50 m between them and with a length of 25,00 m, measured in a horizontal plane on the plinth.

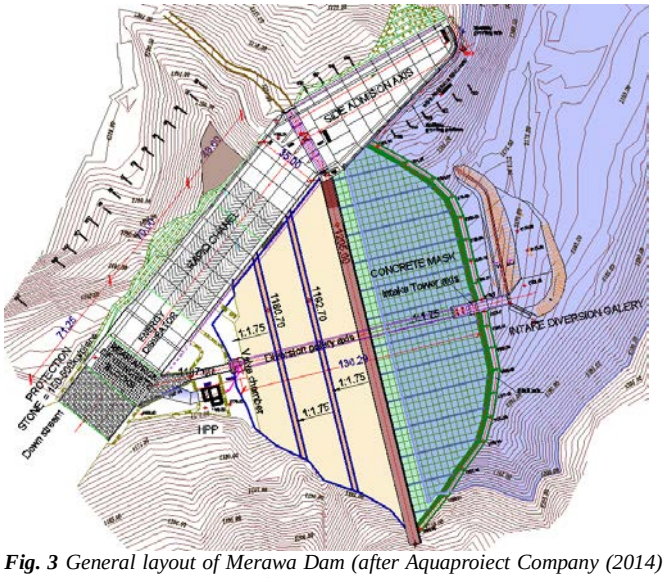

Fig. 3 *General layout of Merawa Dam (after Aquaproiect Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governate / Mawat district.)*

The intake tower is a reinforced concrete structure with horizontal section of 5.00 x 5.00 m and 21.85 m height.

The gallery that is initially used as water diversion during the construction of the works is a reinforced concrete box shaped structure, having the following characteristics:

- B x h: 5.15 x 5.15 m
- Wall thickness: 0.70 m
- Total length: 124.60 m

The bottom outlet is a steel pipe of 1000 mm diameter, consisting of an upstream penstock and downstream, in the valve chamber, with 2 gate valves. The bottom outlet allows emptying of the reservoir in 78 hours.

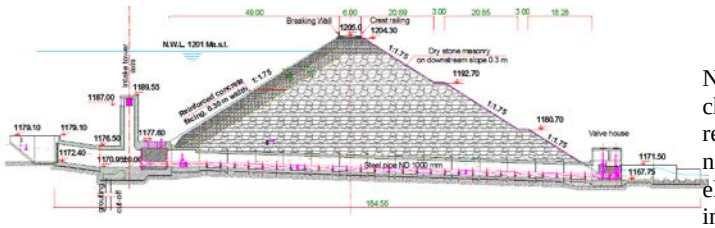

Fig. 4 *Characteristic cross section (after Aquaproiect Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governate / Mawat district.)*

The spillway is placed on the right bank and has the following components:

- The side admission overflow
- The rapid chanel
- The constructions for energy dissipation

The side admission overflow high water diversion is located on the right bank and is a reinforced concrete structure, consisting of an ogee weir and a collecting channel with variable width (10.00 to 35.00 m) with a 1% longitudinal slope.

The construction continues with a rapid channel with increased roughness to limit the velocity at 7 m/s.

The total length of the channel is 124.50 m. The channel section is trapezoidal shape, base width is 35m.The structures for energy dissipation consist of: energy dissipater, rear apron of concrete blocks, and protection stone below dam. The energy dissipater is a reinforced concrete structure, with a total length of 25.0 m, this have a rectangular cross section, with the width of the base of 35 m..

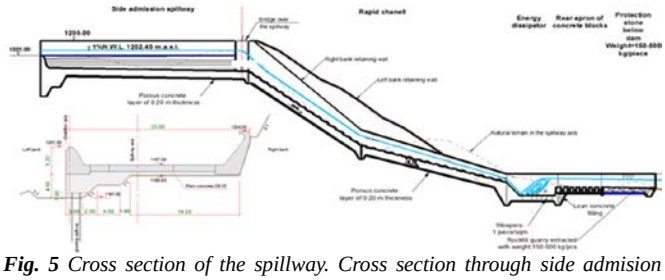

Fig. 5 *Cross section of the spillway. Cross section through side admision (after Aquaproiect Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governate / Mawat district.)*

Power is very important for the development, it is an important infrastructure parameter which aids the economic growth of any country.

There has been recently an ever increasing demand for greatest power generation in almost all countries of the world and especially in Iraq. Hydroelectric power generation is considered one of the most practical, clean (Environment Friendly) and economical nearly 30 % of the total power generation in the world is supplied by hydropower stations, and in some cases rising up close to 100%.

The hydrologic study of Merawa Dam project proved the possibility of power generation by releasing the water to Cham-I Daraban River through a Mini Hydro Station. The power plant is proposed separated from the dam body and will be constructed as a rectangular shape-top view- structure.

The access to the power plant will be provided with an access road along the downstream bottom outlet which will be achieved in the downstream regulated area. The power house is located about 100 m downstream from Dam longitudinal axis where the ground elevation ranges from 1167.5-1168.50 m. a. s. l. Merawa dam is proposed to be built in order to develop the adjacent area. Merawa village is made of 30 households and the village adjacent neighboring valley has a total of 20 households.

The population that lives here is approx. 200 inhabitants.

Villages do not have electricity in the area, with projects of National or Local Grid extension in the area at a halt, with small chances of accomplishment. For daily food preparation or heating, residents are using wood and fossil fuels. During the night they are not running lights, only lanterns and candles. Also due to lack of electricity they are completely isolated from the rest of territory information since they can`t use the radio or TV.

The operation rules for Merawa reservoir are to be fixed on the bases of the following factors:

- Power generation;
- Supply irrigation water;
- Supply water for population consumption;
- Facilitate the maintenance of recreational water areas;
- Regulate the flow downstream of the Merawa Dam.

Reservoir operation is necessary to be made in such a manner that it functions according to the respective purposes of its design.

Merawa Reservoir will use approx 1.5 Million Cubic Meters of the total storage capacity, between normal operation water level of 1201.00 m.a.s.l. and minimum operation water level of 1187.00 m.a.s.l, for power generation, and water supply.

The operation rules for Merawa Reservoir are to be fixed on the bases of the following factors:

- Irrigation and power generation are carried out within the range of the live storage capacity of 1.5 MCM.
- The power plant will use water from bottom outlet, from the steel pipe with ND 600 mm, designed for maximum discharge of $0.5 m^3/s$.

- Operation is done in a manner that waste spillage from the reservoir is minimum.
- High-water-level operation is performed as a rule to ensure stable output over a long period. In addition, this will maximize the energy production.
- Operation for power generation is performed in such a manner that the necessary irrigation water is secured even in fairly dry years.

In order to determine the amount of hydroelectric power that can be generated efficiently, it is necessary to estimate the quantity of water and head available at the site of turbines. The total available water is estimated below.

Table 1. *Estimate the quantity of water*

Months	Inflow (m^3)	Area (m^2)	E (mm)	P (mm)	(P-E)*A/1000 (m^3)	Demand (m^3)	Net inflow (m^3)	Storage (m^3)
April	240084	153100	132.4	89.2	-6614	4000	229470	1853676
May	747628	153100	203.9	34.8	-25889	111082	610657	1853676
June	0	153100	325.6	0.4	-49788	230013	-279801	1573875
July	0	137111	343.9	0.0	-47152	297988	-345140	1228735
Aug	0	117641	311.9	0.3	-36657	316101	-352758	875977
Sept	0	95661	228.2	1.9	-21648	267494	-289142	586835
Oct	0	76801	153.7	33.1	-9262	243132	-252394	***334441***
Nov	165975	56224	94.3	56.2	-2142	36651	127182	461623
Dec	2330312	67282	50.2	99.2	3297	4000	2329609	1853676
Jan	2832539	153100	45.7	118.7	11176	4000	2839715	1853676
Feb	3058142	153100	56.3	123.8	10334	4000	3064476	1853676
Mar	2946078	153100	106.5	90.3	-2480	4000	2939598	1853676

Fig. 6 *2015 photo Merawa village (after Aquaproiect Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governate / Mawat district.)*

The power of the power plan is:

Pmax = 0.7x9.81 x 0.5 x 33.50= 115.02 kW = 0.15 mW

The minimum power of the power plan is:

Pmin = 0.7 x 9.81 x 0.5 x 18.50 = 63.51 kW = 0.06 mW

Generator power range – from 60 -150 kW.

- Runner Diameter: 392 mm
- Net Head at Rated Discharge: 33.42 meters
- Unit Speed: 750.0 rpm
- Peak Efficiency: 91.8 %

Fig. 7 *Energy requirements*

So considering there are 50 households, and the SHPP produces 150 kW and maximum consumption is 3 kW per household, we deduct that it can ensure the necessary electricity for the households neighboring Merawa dam. Irrigation corresponding Merawa dam, will take place both upstream and downstream of it.

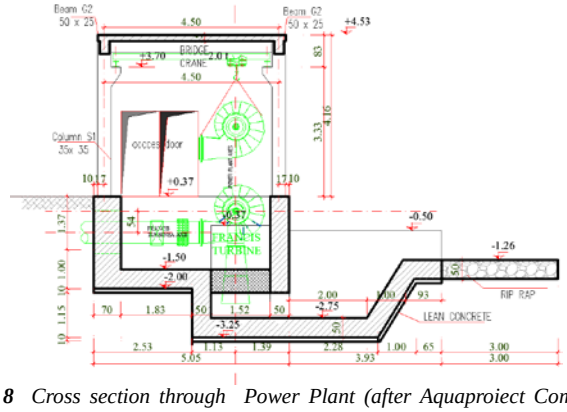

Fig. 8 *Cross section through Power Plant (after Aquaproiect Company (2014) Feasibility study and design for Merawa dam in Sulaimaniya Governate / Mawat district.)*

The irrigation network was designed to ensure 20 ha upstream of the storage reservoir (Plot1).

Plot 1, a surface of 20 ha, will be supplied by pumping via a CP main pipe made of PEID 100, NP 10, with diameter 315 mm starting from the pumping station. The design capacity is 55,28 l/s.

For pumping the water for irrigation a group made of 2 centrifugal electro-pumps with following particularities and pump flow of 100 m^3/h was designed. Plot 2, surface 8 ha, will be located downstream of the dam, on the right river bank (fig. 9).

This surface is located between the channel and the right river shore, where the flank is smaller in comparison to flanks of surrounding slopes. The water will flow gravitationally ensured via a main pipe with a length of 50 m and diameter or 315 mm, connected upstream to the vanes chamber (split T). From the irrigation channel the necessary volumes of water for irrigating the agricultural crops will be provided. At the channel slope of 0.5 ‰, the channel transport capacity will be of maximum 31 l/s and the velocity v = 0.34 m/s.

Irrigation will usually be in June - October months, but if necessary can also be used and controlled in the other months depending on other necessities and on the water level in the reservoir.

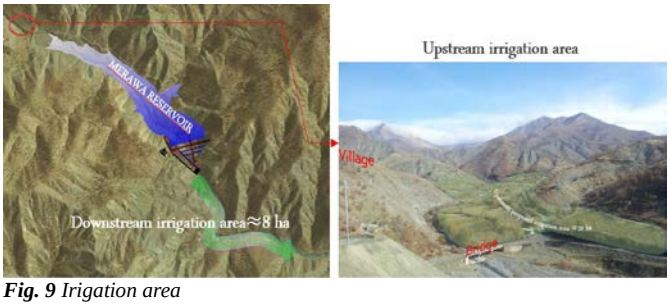

Fig. 9 *Irigation area*

4. Conclusion

Merawa dam is proposed to be built in order to develop the adjacent area.

The water reservoir volumes studied for this dam were limited and conditioned so that the artificial lakes will not affect the villages or other property and equipment located in the perimeter of the inhabited areas.The proposed works consist in a dam on river course which aims to provide water for electricity producion, irrigation and water supply of the residential areas.

The Dam and micro-HPP will be able to provide the area with base energy, with a sturdiness granted by the volume of the reservoir, as now the only power sources are isolated fossil-fueled generators. The energy produced by the 60 - 150 kW turbines might seem small, but the community will be able to rely on this source as its primary supplier. All 50 households will have electrical energy.

This is a classical example of a Greenfield development that proves to be ecologically and economically viable in the given conditions.The purpose of the works, however costly they might be, is the only way to provide the village with necessary means of adequate living conditions for the inhabitants. The Power plant can be used 9 month per year (December, January, February, March, April, May, June, July, August) but it will provide most of the now almost non-existing power supply.

Irrigation surface is 28 ha, downstream and upstream of the dam, further suppling the community with the neccesarry means of self sustainment.

In such remote places, with the high envolvment of the local government, this example of design and works are a strong statement that hydrotechnical works are the stepping stone for both civilisation thriving and ecological durable development.

5. Acknowledgements

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6. References

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2.SETEC Company (2011) Kurdistan Region Water Infrastructure Sector Master Plan