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REVIEW ON REPLACEMENT OF CONVENTIONAL STEEL PLATE NEEDLES BY FRP NEEDLES IN K. T. WEIRS

Aniruddha N. Chavan[1], Prof. Umesh L. Deshpande[2]

1 PG Scholar (M. Tech – Construction Management),
2 Associate Professor (Applied Mechanics Department),
1 2 Government College of Engineering, Karad, Maharashtra [India]

Abstract— India, being a tropical country, most of the rivers flow during monsoon only. The quantity of water available in river channels to meet various water demands (particularly irrigational) reduces marginally once monsoon surpasses. Therefore, to make perennial availability of water in river channels, check dam technology and water storage techniques are under practice. The K. T. Weir technology, a part of above-mentioned techniques emphasizes on water storage by using steel plate needles conventionally. With the reference of effectiveness of FRP needles over M. S. Needles, this paper reviews the use of modern FRP needles over conventional steel plate needles, their design specifications, manufacturing, installation, working, maintenance, durability and cost effectiveness in pocket irrigation schemes. This paper also includes a case study of FRP needles installation in check dams of Odisha state.

Keywords: Water demands, K. T. Weir technology, Steel plate needles, FRP needles, durability.

I. INTRODUCTION

India, being a tropical country, most of the rivers flow during monsoon only. The quantity of water available in river channels to meet various water demands (particularly irrigational) reduces marginally once monsoon surpasses. Therefore, to make perennial availability of water in river channels, check dam technology and water storage techniques are under practice. The K. T. Weir technology, a part of above-mentioned techniques emphasizes on water storage by using steel plate needles conventionally. This report reviews the use of modern FRP needles over conventional steel plate needles, their design specifications, manufacturing, installation, working, maintenance, durability and its overall cost effectiveness in pocket irrigation schemes.

II. CONCEPT OF K. T. WEIR AND FRP GATES

The technique of constructing a special type of weir across the river bed to store the water in post – monsoon season, was first implemented in Kolhapur district (Maharashtra) back in the era of Rajarshi Shahu Maharaj for meeting the agricultural water demand once monsoon surpasses. K. T. Weir (Kolhapur Type Bandhara) is a structure to be constructed transverse to the flow of natural stream channel having considerable gap between two piers to allow the passage to water stream. These gaps being sealed with needle gates to restrict the flow of water so as to store it for future use when channel is having water deficit and do not have enough water to serve the human needs. This creates a storage reservoir at the upstream side of the structure which is being majorly used for fulfilling various water demands. Particularly, it is a non-overflowing weir with a concrete deck at top which can be used as a bridge for light to medium traffic.

The K. T. weir gates will be put in operations at the end of tropical monsoon since storage of considerable amount of water can be done. These gates are either manually operated or mostly operated with hoisting equipment. Since the ages, the gates were conventionally made from Mild Steel and reinforced with bracing to provide the strength. In modern day practice, the conventional material is replaced with the FRP needle gates to achieve the efficiency in operations.

III. LIMITATIONS TO CURRENT PRACTICES IN K. T. WEIRS

A single Mild Steel plate weighs 70-75 kg, which consumes a heavy set of equipment requirement to transport them at the site. Further to transportation, these are also very heavy to carry out the installation activities with utmost comfort. It needs chain and pulley arrangement mounted on a crane to lower a single plate at its pre-determined location.

As mentioned earlier, the conventional gates are made with Mild steel, which is prone to corrosion and various environmental attacks due to exposure conditions. Due to corrosion, the life of M.S. gates is not more than 5 years and which also involves lot of maintenance works during the lifetime. M. S. plates are prone to leakages as corrosion ultimately results in rusting out and scouring of the plate material. Due to sizable scrap value, M. S. needles are prone to pilferages.

IV. CONCEPT OF FRP NEEDLE GATES

FRP needle gate is sandwich structure of M.S. frame and fiberglass reinforced plastic (FRP) material. M. S. structure is covered from all sides by FRP material and it is not exposing anywhere to water. Fiberglass (FRP) Plastic material is 100% anticorrosive and free from any atmospheric effects. FRP is sturdy material and impact strength is just like steel. FRP is thermosetting plastic and just like rubber, cannot be melt or reshape and hence having no resale valve. Durability of composite gates in normal conditions is for 15 to 20 years and has absolutely no maintenance.

V. DESIGN SPECIFICATIONS OF FRP NEEDLES

Design specifications of FRP needle gates includes the featured of both M. S. plates and Fiberglass plastic to meet the eccollectiveness of both the structures.

Scope of Material

Moulded Fibre Needle gate for K.T. Weir of size of 2.05 meter x 0.5 meter, made of composite material fiberglass reinforced plastic (F.R.P.) with both side gelcoat finish in eyeplesant blue colour sandwiched with M.S. prefabricated structure made in 40 x 40 x 6mm M.S. 'T' angle and 70 x 35 channel at both ends, embedded in polyester resin and glass rovings by spray – up moulding process, covered total M.S. structure from all sides in FRP moulding, moulded and engraved gauge marking from 0 to 0.5 meter with one centimeter least count, project name covered in retro reflective for front portion of needle, hooks for lifting in 8 mm slots, holes to cleats for assemble / disassemble needles, rubber pads 50mmx8mmx500mm for both side and top rib to avoid leakages etc. complete.

FRP needle gates are designed with STAADpro software for 2.0 tonnes load under UDL Size of composite gate is 2.15 M (W) x 1.0M (H) and can be adjusted in width as per site conditions. Special lifting mechanism is developed for which chain pulley block is not required.

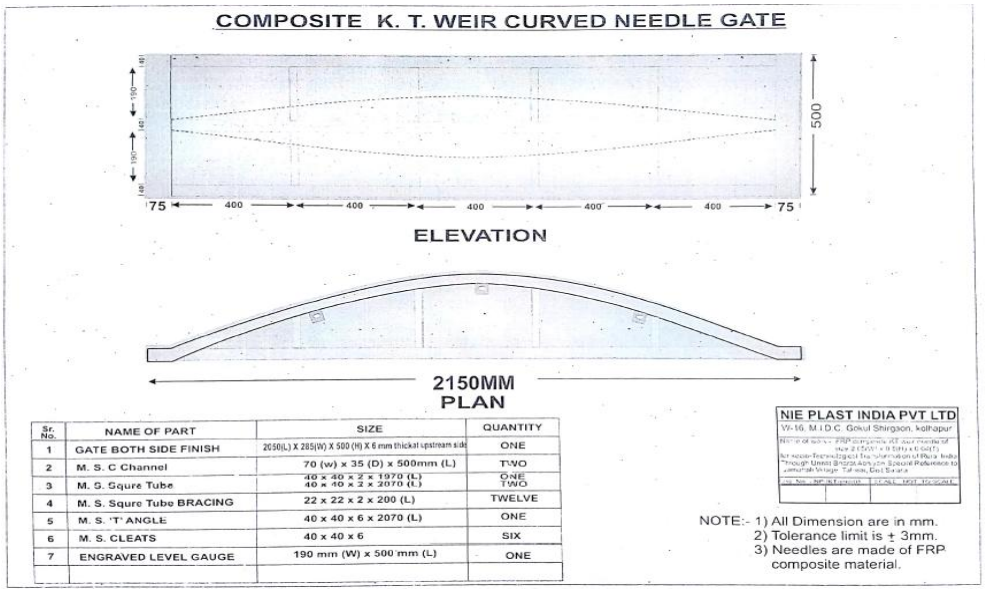
Material Specification

Fiberglass Reinforced Plastic (F.R.P.)

a) Reinforcement – CSM – 450 – 3 Nos. and WR – 600 – 1 No.

b) CSM – Chopped strand mat, emulsion grade – E glass type, density 450 gms / m^2

c) WR – Woven roving – E glass type density 600 gms/ m^2



Sr. No.	NAME OF PART	SIZE	QUANTITY
1	GATE BOTH SIDE FINISH	2050(L) X 285(W) X 500 (H) X 6 mm thickat upstream side	ONE
2	M. S. C Channel	70 (w) x 35 (D) x 500mm (L)	TWO
3	M. S. Squre Tube	40 x 40 x 2 x 1970 (L) 40 x 40 x 2 x 2070 (L)	ONE TWO
4	M. S. Squre Tube BRACING	22 x 22 x 2 x 200 (L)	TWELVE
5	M. S. 'T' ANGLE	40 x 40 x 6 x 2070 (L)	ONE
6	M. S. CLEATS	40 x 40 x 6	SIX
7	ENGRAVED LEVEL GAUGE	190 mm (W) x 500 mm (L)	ONE

Fig. No. 1.1 K. T. Weir Gate *(Source: Nie Plast India Pvt. Ltd.)*

Table 1.1 Mechanical Properties of Composite

Sr. No.	Mechanical Property	Unit	Value
1	Glass content by weight	%	25 - 30
2	Density	Mg/m^3	1.4 - 1.5
3	Tensile strength	N/mm^2	60 - 120
4	Compressive strength	N/mm^2	100 -170
5	Flexural strength	N/mm^2	110 -190
6	Impact strength	J/m	210 - 340
7	Water absorption	Kg x 10^{-6}	15 - 25

Table 1.2 Specifications of FRP Needle Gates

Sr. No.	Particular	Dimension
1	Length of FRP needle gate	2050 ± 5 mm
2	Height of FRP needle gate	500 ± 5 mm
3	Width of FRP needle gate	40 ± 2 mm
4	Gauge width with figures	100 ± 5 mm
5	Gauge least count	10 ± 1 mm
6	Gauge height	500 ± 5 mm
7	Radial curve depth	235 ± 8 mm
8	Weight	55 ± 5 kg

VI. Salient features of FRP needles

Light in Weight but Sturdy

FRP gates are 50% light in weight compare to steel gates. This helps for easy transportation, pulling and inserting gates in channel at site with minimum manpower.

Maintenance Free

Composite gates are made of FRP material which itself is 100% anticorrosive and having zero atmospheric effects of heavy rains or summer season. So, no damages or pit holes due to corrosion like MS gates and every year painting by epoxy paint is not required, General life of FRP material is 20 to 25 years with same strength and hence very durable.

Repair of Gates

For repair of M.S. gates, it has to bring to workshop or to make arrangement of generator set for welding. FRP composite gates can be repaired at site without any electricity with chemicals only and can work as before in littlie repair cost.

Pilferages of Gates

MS material has excellent resale value in local market. Check dam sites are in far interior places and due to small project security deploying for 24 hours is just impossible. MS gate weight is around 100 Kgs with brass plates and many time, department has faced pilferages problem. FRP composite gates cannot melt or reshape and easily traceable as project name is mentioned on gate. Hence chances of pilferages are very rare.

Level Gauging & Project Name

On FRP gates upstream side engraved and moulded level gauging filed with readium is given for water level measurement in check dam. As radium is used even in night level is visible. Project name is also engraved on gates for not to misuse of gates for any other project.

Special Lifting Mechanism

MS check dam gates have to put or lift by chain pulley block with minimum three to four labours, which is very difficult task. In composite check dam gates, frame is given from all four sides and gate will lift or lower down with lifting mechanism as shown in following picture.

This lifting mechanism can be carried with motor cycle and with the help of one labour, it can adjust to 25%, 50%, 75% and 100% opening position as per the demand of farmers. This will help for easy operation and damages in handing will be totally minimized.

Advantages of FRP Needle Gates

- High Strength
- Light Weight
- High Strength to Weight Ratio
- Design Flexibility
- Ease of Repair
- Durability
-

VII. Rate Analysis

Rate Analysis of 01 (One) MS Needle Gate

Sr. No.	Particular	Qty.	Price (including GST)
1	MS Needle (2.15 × 0.5 × 0.05) Along with lifting arrangements and locking provisions Weight 75-80 Kg	1	6,500 Rs. *(C_1)*

Rate analysis of 01 (One) FRP needle

Sr. No.	Particular	Qty.	Price (including GST)
1	FRP Needle (2.15 × 0.5 × 0.05) Along with lifting arrangements and locking provisions Weight 55-60 Kg	1	14,750 Rs. *(C_2)*

VIII. COST COMPARISON

Cost Comparison between M. S. Needle Gates and FRP Needle Gates

(For 25 years)

Cost of MS Needle Gates for 25 Year Service

Total Cost= $C_1 \times \frac{Total\ life\ under\ service}{Life\ of\ one\ service\ period}$

$= 6{,}500 \times \frac{25}{5}$

= 26,000 Rs. ……..(1)

Cost of FRP Needle Gates for 25 Year Service

Total Cost= $C_2 \times \frac{Total\ life\ under\ service}{Life\ of\ one\ service\ period}$

$= 14{,}750 \times \frac{25}{25}$

= 14,750 Rs. …….(2)

From (1) and (2), it is suggested to use FRP needle gates in long run from achieving economy during service. In long run, FRP needle gates are two to three times as economic as MS needle gates.

Case Study

Manufactured by - Nie Plast India Pvt Ltd, W-16, M.I.D.C., Gokul Shirgaon, Kolhapur- 416234 (MH)

Presently M.S. check dam gates are using in Odisha state for storage purpose. Due to corrosion, life of M.S. gates are not more than five years and chances of pilferages are too high as sites are far interior and security cannot kept due to small projects. Also for lifting and pulling, chain pulley block or crane is required. Composite check dam gates is "Best and Proven Alternate solution" for replacement of M.S. gates. These gate are in use at khandapara check dam gate project in Naupada district since 2014 and working very well from last four years without any maintenance.

IX. CONCLUSION

When we design a bridge cum Bandhara system for a long run operations, use of FRP Needle gates is not only cost effective but also performance efficiency can also be achieved. K.T. Weirs along with FRP needle gates fulfills all the structural requirements and operational demands with utmost efficiency on replacement with steel gates.

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