RCC Design of Connecting Channel "Parshal Flume for a Conventional Water Treatment Plant"

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Abstract — Potable water parameters includes chemical, physical, and biological properties that should be examined based on the required limiting values/ranges of the parameters in question. Traditionally, a drinking water treatment plant consists of aeration, chemical dosing coagulation, flocculation, sedimentation, filtration and disinfection units that are chosen based on the quality of the raw water sample. Each unit is generally optimized to achieve the specified water quality effluent, both during the design and operation stages. The study was carried out to an open channel flow measurement tool called the Parshall flume was created to gauge irrigation and surface water flow rates. It is a fixed hydraulic construction called the Parshall flume. It is used to gauge the volumetric flow rate in municipal sewer systems, wastewater treatment facilities, and discharges. The parallel sides of the Parshall flume contract, causing a drop in the floor at the flume throat and accelerating the flow. The depth of water at a certain place upstream of the flume mouth can be converted to a flow rate under free-flow conditions. This paper will help us in dealing the Parshall flume RCC arrangements for its installation in the conventional water supply treatment projects.

Keywords: Need of Parshall Flume, Design Parameter, RCC

I. INTRODUCTION

Water is currently the most pressing concern for both domestic and urban populations, as it has begun to consume contaminated water near our surface and subsurface resources as a result of rising standards of living, continued civilizational advancement, and industrialization in all spheres. There is need to filter or treat the water in order to ensure that everyone on the planet lives a healthy life. As water contamination is very natural and affects human life directly or indirectly, it requires treating the water before supplying it to the homes in order to protect ourselves from any type of disease. In the treatment plant, a number of units one by one for the treatment of the water using the conventional method of treating raw water for drinking purposes are presented.

Details of units that treats water

1) An aerator, a Parshall flume, and a flash mixer.
2) Chemical/chlorine mixing unit
3) Tanks for coagulation and flocculation
4) Filters (slow or quick sand filters)
5) Storage of clear water
6) Backwater holding

RCC design of the Parshall flume for the water treatment facilities in this essay will examine. In essence, the channels that connect the aeration system to the flash mixer will construct.

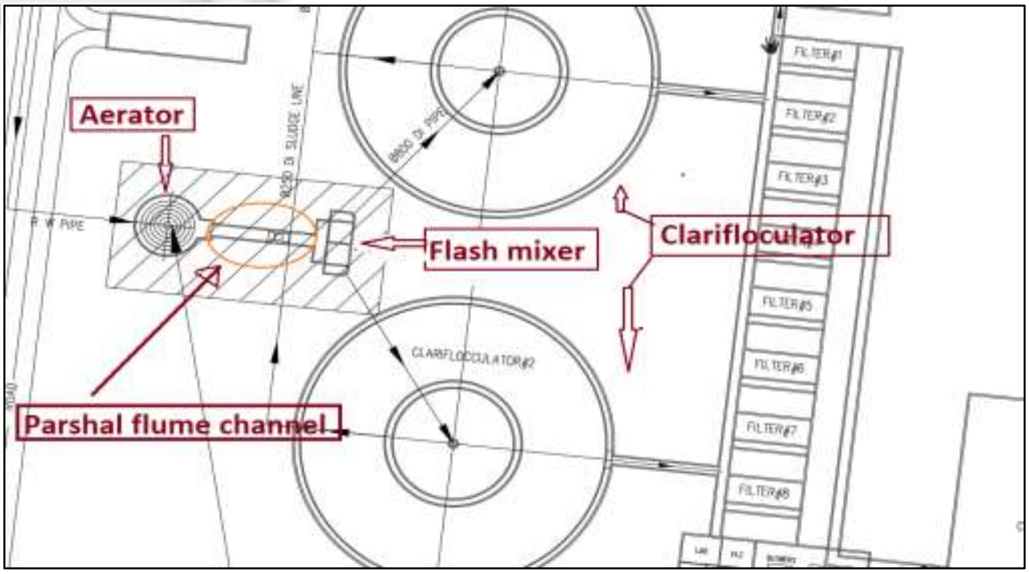


Fig. 1: Location Parshall flume channel structure along with typical water treatment plant units ie, aerator, clari-flocculator, flash mixer, filters.

II. METHODOLOGY

In the view of the methodology some point are need to be discussed here that Cascade aerator is the unit which connected to influent Raw water at one end and Parshall flume in another end which will further connects to the flash mixer chamber. In this paper, the design of Parshall flume base slab, Parshall flume wall including walk way, and its foundation has been carried out.

A. Design Component-

1) Parshall flume: Parshall flume is used to measure the flow and control the flow velocity.

Parshall Flume Parshall Flume is a type of standing wave flume widely used. However, its use requires application of different equations, based on the throat size, if accuracy in results similar to other types of flumes is expected. The approximate equation applicable for the entire range of its usage, namely, discharges varying from 0.001 m3 /s to 100 m3 /s (i.e., throat widths varying from 75 mm to 15,000 mm) is given by: Q = 2.42 Wh2.58 (8.10) Where; Q = discharge in m3 /s W = throat width in m and h = upstream gauged depth in m, The numerical factors 2.42 and 2.58 are subject to 4% variation in extreme cases (less in case of smaller widths). The minimum head and accuracy will be the same as for standing wave flumes. IS: 14371/ ISO: 9826 prescribes various methods to be adopted for measurement of flow of water in open channels through Parshall Flume in water treatment plant. Simplified formulae of measurement of flow in open channels 90° V notches: Q = 1.38 Hw 5/2 Rectangular Weir/notch: Q = 1.84 B Hw 3/2 Parshall Flume: Q = 2.27 W Ha 3/2. Where; Q = Discharge (m3 /sec) Hw = Head on weir (m) Ha = Depth at entrance to the flume at specified measuring point (m) B = Length of the weir (m) W = width of throat (m)

Fig. 2: Ultrasonic Flow Indicator over Parshall Flume

B. Design of Parshall flume –

Design steps –

1) Load calculations
2) Calculation of bending moment
3) design for shear at base
4) Crack width for flexural effect.

1) WALL design one way as cantilever –

For example Length of Parshall flume channel Wall	14 Meter.
Wall Height above base Slab =	1.43 M
Service water ht.=	0.93 m
Aspect ratio= 14/1.43 =	9.790
Assume Wall thickness =	0.150 M
As the aspect ratio =	> 3,
Wall is designed -	One way vertically spanning as cantilever.
Loading from Water Full ht.	14.300 KN/SqM

Design of B.M at Base (level 143.97 M) –

Bending moment at base due to water Load	= WxHxHxH/6
Where W	= 10.000 KN/Cum
H= 1.450 M Moment full ht.	

B.M = 5.081 KN-M

– Moment service ht. B.M = 1.341 KN-M
– Load on wall due to walkway = 6.000 KN/M

Moment due to walkway on wall =3.000 KN-M

Total moment = 5.081+3.000=8.081
Mu= M x 1.5 12.122 KN-M
D= 150.000 MM
Cover to steel =45.000 MM
Bar Diameter adopted= 10.000 MM
d= 100.000 MM
b= 1000.000 MM
Mu/b/d/d = 1.2 MP

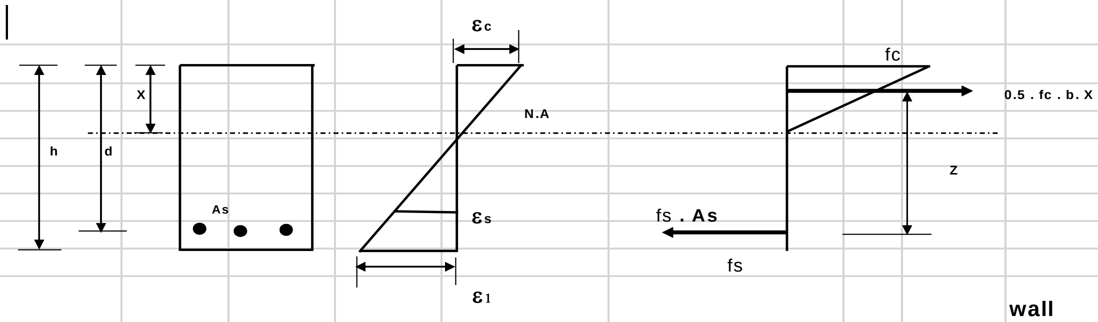
Refer table 4 SP16, Fy 500 ,
Pt = 0.290
Ast= 290.000 sqmm/M
Min. steel 0.35% required = 525.000 Sqmm
10T @ 140c/c at mid layer 560.710 Sqmm
OK

Design for shear at Base = H x H /2 x10

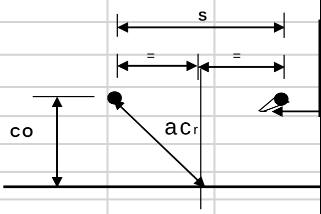
Shear force due to water= 10.513 KN
Total Shear=V= 10.513 KN
Vu=1.5x V 15.769 KN
Shear Stress =Vu/b/d = 0.158 Mpa
Pt required= 0.56 %
Allowable shear as per table 61 SP16 0.524
Ast Provided= 560.710 Sqmm/M

Crack width of wall=

CRACK WIDTH FOR FLEXURE EFFECT



wall



Grade of Concrete Used (fcu)	=	N/mm^2	30
Grade of Steel Used (fy)	=	N/mm^2	500
Area of Reinforcement " As "	=	mm^2	560.71
Width of Section b	=	mm	1000
Depth of Section h	=	mm	150
Effective Depth of Section " d "	=	mm	100
Minimum Cover to Tension Reinforcement " CO "	=	mm	45
Maximum Bar Spacing " S "	=	mm	140
Bar Dia	=	mm	10
" a_{Cr} " = (((S/2)^2 + (CO + DIA/2)^2)^(1/2)-DIA/2)	=	mm	81.02
Distance From the Point Considered to the Surface of Nearest Longitudinal bar			
Applied Service Moment " Ms "	=	KNm	8.08
CALCULATION :			
Moduli of Elasticity of Concrete " Ec " = 5000x (sqrt(fcu)) =		KN/mm^2	27.39
Moduli of Elasticity of Steel " Es " =		KN/mm^2	200.00
Modular Ratio " α " = (Es/Ec)	=		14.61
"ρ" = As/bd	=		0.00561
α.ρ	=		0.08
Depth of Neutral Axis, " **X** " = d.α.ρ(((1+(2/α.ρ))^0.5)-1)	=	mm	33.10
Lever arm " Z " = (d - X/3)	=	mm	88.97
Reinforcement Stress " fs " = Ms/(As*Z)	=	N/mm^2	161.98
Concrete Stress " fc " = (fs*As)/(0.5*b*X)	=	N/mm^2	5.49
Strain at Soffit of Concrete Slab " ε_1 " = (fs/Es)*(h-X)/(d-X)	=		0.00142
Strain due to stiffening effect of Concrete between the Cracks " ε_2 "	=		0.00061
ε_2 = b . (h-X)2/(3.Es.As.(d-X)) for Crack Width of 0.2mm			used
ε_2 = 1.5 .b . (h-X)2/(3.Es.As.(d-X)) for Crack Width of 0.1mm			not used
Average Strain for Calculation of Crack width " ε_m "	=		$\varepsilon_1 - \varepsilon_2$
	=		0.00081
Calculated Crack Width , " W " = 3.acr.ε_m/(1+2.(acr-CO)/(h-X))			
Calculated Crack Width " W "	=	mm	0.122

2) *Design of Parshall flume slab: -at 143.97 level.*

Clear Short Span =Lxc	1.6 M
Clear Long Span =Lyc	4.63 M
Slab Thickness Provided =T	0.15 M
Effective Short Span = Lx	1.75M
Effective Long Span =Ly	4.78M
Aspect Ratio Ly/Lx 2.7314	One way design
As aspect ratio >>> 2	One way Design
Dead Load Slab	3.75 KN / SQM
Floor Finish 3.5 KN/sqm	3.5 KN/sqm
Water Load 14.3 Kn/sqm	14.3 KN/sqm
Total UDL 21.55 Kn/sqm	21.55KN/sqm
B.M adopted = W x L x L /10=M	6.599688 Kn-M
Mu=1.5xM	9.899531 KN -M
D provided =	150 mm
Clear Cover Provided =	20 mm
Bar diameter=	8 mm
Effective Depth d =	126 mm
Mu/b/d/d, where , b=1000	0 .6 MPA
Refer table 3 SP-16,fy=500, Pt= 0.141 %age	
Ast= 177.66 Sqmm	177.66 sqmm
0.35% Min. steel required	5.25
560 Sqmm , Provided Top and Bottom	T10-140
OK	

Check for Deflection= Refer Cl.23.2.1 of IS456-2000

Basic Value of Span/effective Depth=	20	fs=Steel Reqd./Steel Prov. X 0.58Fy	92.0025
Continuity fact. =	1	Ref. Fig 4 IS 456-2000	
Pt Provided =	.44	Modification factor	1.6
		Depth required d =	54.6875mm

3) *Design of Parshall flume channel wall as beam: - Beam 150x1430:-*

Self-Load of the beam =	5.363 Kn/M
Loading from walkway slab = (0.125x25) =	3.125 Kn/m
Total UDL=	8.488 Kn/M
Live load on walkway slab=	3.000 Kn/M
Resultant UDL =	11.488 Kn/M say 12Kn/M
Span of the beam =	4.63 M
M=	32.155 Kn-M
V=	27.78 KN
Mu=1.5xM =	48.233 Kn-M
d=1430-45-10=	1375 MM
b=	150 MM
Mu/b/d/d=	0.170 Mpa

Refer table 4 SP16 Fy 500

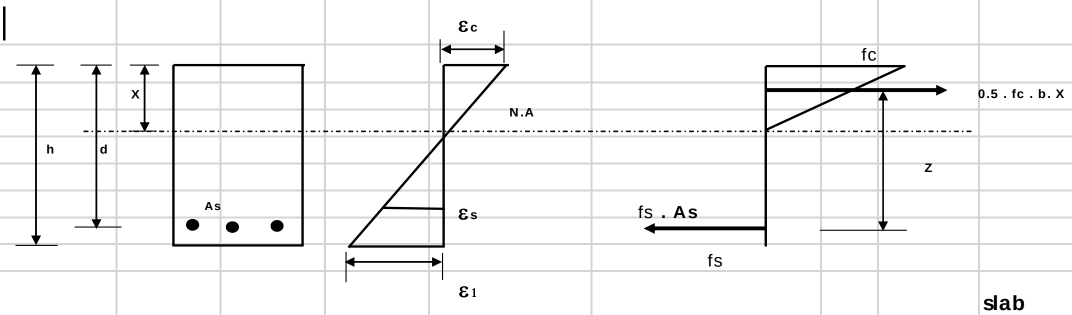
Pt =	0.0700 %age
Ast =	144.375 Sqmm
Provided=	2 Nos T10 B
Ast provided =	160 Sqmm
Pt provided =	0.078 %age

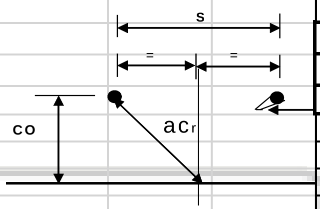
Refer table 61 SP16 M30

Allowable shear stress =τc 0.200 MPa (corresponding to pt at top)
Shear Stress Developed = 0.202 Mpa
Shear stress to be resist. by steel = 0.002 Mpa
Vus= 0.420 Kn Vus/d
0.003 Kn/cms
Nominal shear Steel required T10-140 ok pt

Provided corresponding to bottom R/F = 0.08
fs 261.68 N/mm2
Corresponding modification factor as per Fig.4, Page-38, IS: 456-2000= 1.20
Effective thickness required as per clause 23.2.1(a), Page-37, IS: 456-2000 =192.92 mm << 1375 mm effective
So, Depth provided (OK)
Crack width of slab=

CRACK WIDTH FOR FLEXURE EFFECT

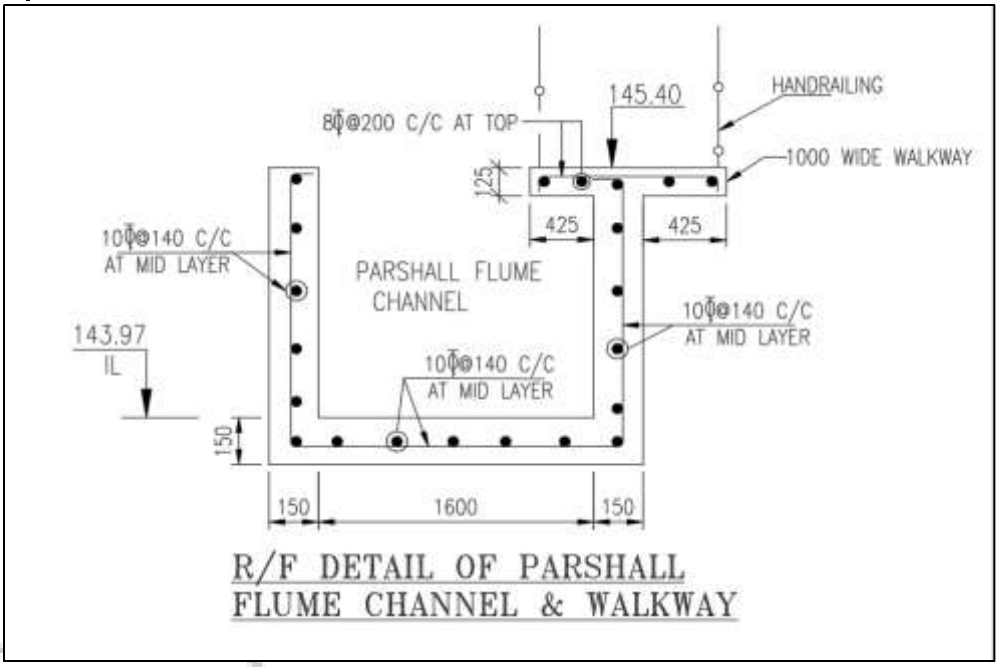




Grade of Concrete Used (fcu)	=	N/mm^2	30
Grade of Steel Used (fy)	=	N/mm^2	500
Area of Reinforcement " As "	=	mm^2	560
Width of Section b	=	mm	1000
Depth of Section h	=	mm	150
Effective Depth of Section " d "	=	mm	100
Minimum Cover to Tension Reinforcement " CO "	=	mm	45
Maximum Bar Spacing " S "	=	mm	140
Bar Dia	=	mm	10
" acr " = (((S/2)^2 + (CO + DIA/2)^2)^(1/2)-DIA/2)	=	mm	81.02
Distance From the Point Considered to the Surface of Nearest Longitudinal bar			
Applied Service Moment " Ms "	=	KNm	6.60
CALCULATION :			
Moduli of Elasticity of Concrete " Ec " = 5000x (sqrt(fcu)) =		KN/mm^2	27.39
Moduli of Elasticity of Steel " Es " =		KN/mm^2	200.00
Modular Ratio " α " = (Es/Ec)	=		14.61
"ρ" = As/bd	=		0.00560
α.ρ	=		0.08
Depth of Neutral Axis, " **X** " = d.α.ρ(((1+(2/α.ρ))^0.5)-1)	=	mm	33.09
Lever arm " Z " = (d - X/3)	=	mm	88.97
Reinforcement Stress " fs " = Ms/(As*Z)	=	N/mm^2	132.47
Concrete Stress " fc " = (fs*As)/(0.5*b*X)	=	N/mm^2	4.48
Strain at Soffit of Concrete Slab "ε1 " = (fs/Es)*(h-X)/(d-X)	=		0.00116
Strain due to stiffening effect of Concrete between the Cracks " ε2 "	=		0.00061
ε2 = b . (h-X)2/(3.Es.As.(d-X)) for Crack Width of 0.2mm			used
ε2 = 1.5 .b . (h-X)2/(3.Es.As.(d-X)) for Crack Width of 0.1mm			not used
Average Strain for Calculation of Crack width " εm "	=		ε1 - ε2
	=		0.00055
Calculated Crack Width , " W " = 3.acr.εm/(1+2.(acr-CO)/(h-X))			
Calculated Crack Width " W "	=	mm	0.083

III. CONCLUSION

As the results show the RCC structure details for the different small components of Parshal flume like RCC details of wall, base slab, walk way of Parshall flume.



It is clear to decide the RCC quantity as well as steel quantity consumed by the particular units of the Parshall flume channel system which is the finals AIM of this paper summary of the design is mentioned above in the drawing.

Over all it has been found that minimum 10 MM dia. of steel is essential with spacing of 140 c/c at mid layer of the base slab (150 mm thick and wall of Parshall (150 mm thick) flume channel, although in walk way (thickness -125 mm and both side cantilever action slab projected 425 mm)position of the reinforcement (dia- 8 mm,200 centre to centre)shifted up wards slightly at minimum cover.

IV. REFERENCES:-

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