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DesignofCascadeAeratorforurbanareawatertreatmentplant

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ABSTRACT

A potable water parameters consist of chemical, physical, and biologicalproperties and should be tested based on the desired limiting values/ranges of parameters concern. Conventionally drinking water treatment plant consists of aeration, chemicaldosing coagulation, flocculation, sedimentation, and filtration and disinfection units which will be decide based onqualityofraw water sample , eachunit are generallyoptimized to realize the specified water quality effluent, both in designandoperation stages. The study was carried outto requirement ofaerationprocess and designofaerationunit for the water qualityand its suitability for drinking purpose.

Keywords-Needofaeration, Designparameters,andcascadeAeratorandParshall flume.

INTRODUCTION

As we know that nowadays water is the most criticalissue for the domestic as well as urban area people, because with increasing the standard of life style, future development of civilization and industrialization in all sectors somewhere we started consuming the polluted water around our surface as well as sub surface resources. In order to gethealthy life of allthe people around the world we need filtration or treatment of the water. In order to protect our self-from the any type of disease as we know that contamination of the water is very natural which affects directly or indirectly to the life of the human beings for the prevention we need to treat the water before the supply to the households we encountered number of units one by one for the treatment of the water in the treatment plant by the conventional method of treating raw water for drinking purpose.

DifferentunitsofWatertreatmentplant-

1) Aerator,Parshallflume&flashmixer
2) Chlorine/chemicalmixingunit
3) Coagulationandflocculationtanks
4) Filters(Slowsand filterorrapidsandfilters)
5) Clearwaterstorage
6) Backwater storage

Inthispaper wearegoing toseetheRCCdesignofParshall flumedesignfor the aerators.

Aeration -This is often adopted to get rid of objectionable tastes and colour and also to get rid of the dissolved gases like carbon dioxide, hydrogen sulphide etc. The iron and manganese existing in water also oxidized to some extent. This process is optional and isn't adopted in cases where water doesn't contain objectionable taste and odour. In our case we adopted cascade aerator. With cascade aerators, aeration is accomplished by natural draftunits that blend cascading water with air that’s naturally inducted into the water flow.Cascadewater ispumped to thehighest oftheaerator, and cascadesover a seriesoftrays. Air is ofcourse inducted intothe waterflowto accomplish ironoxidationand a few reductions in dissolved gasses.

Methodology

In the view of themethodology some pointare need tobe discussedhere that Cascade aerator is the unit which connected to influent Raw water at one end and Parshall flume inanother end whichwillfurther connectstothe flash mixer chamber. Inthis paper we will only see the design of cascade aerator RCC structure –

Designofcascadeaeratorunits– Design

steps –

1) Loadcalculations

2) Calculationofbendingmoment–required

3) Areaofsteelrequired and provided

3) Designforshearatbase

4) Crackwidthforflexuraleffect.

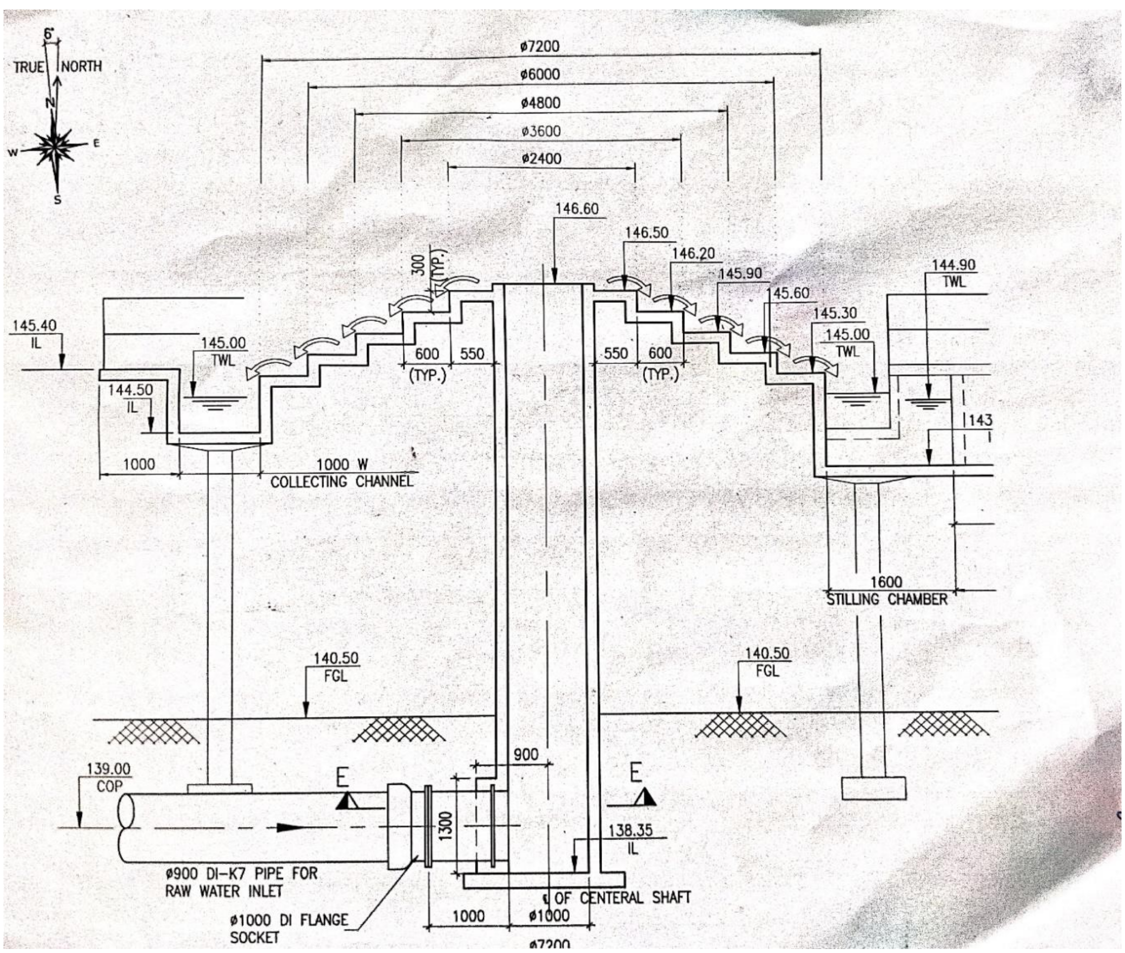

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Fig-1showingtypicalcrosssectionalviewofcascadeaerator. Different

Components of cascade aerator-

Baseslabofcascade aerator

1) Centralshaft

2) Steps (pan)

3) Collectingchannels

4) Siltingchamber

5) Footing

- **DesignofCascade Aerator:-**

1) Baseslabofcascadeaerator

2) Designofcentralshaft

3) Designofshaftasannularcolumn

4) DesignoffoundationofCentralshaft

5) Designofconicalslab

6) Designof walkway

1) DesignofBase SlabofCascadeAerator:-

- Base slabisdesigned asone way spanning from Beam atone end and central shaft at other Ends.
- HorizontalSpan=2.90M(ReferDwg.)
- SlopeofTheSlab=63.00

Degree Loading Adopted:-

- Typicalcleartroughlength0.60M
- RCCstepHeightasperDwg=0.30M
- stepLoad/Sqm=4.50KN/Sqm
- Self-LoadBaseSlab
- SlabthicknessProvided0.175M
- Slabload4.38KN/Sqm
- TotalUDL8.88 KN/Sqm
- LoadonProjectedlength19.5KN/Sqm
- Say20.00KN/Sqm

- Widthofthestripat columnCenterLine1.00 M
- Diameteratthis Location7.20M
- DiameteratCentralshaftlocation1.00M
- LoadintensityatBeamLocation20.00KN/M (1 x19)
- Slabwidthat CentralShaft Loc.0.139M=1x1/7.2

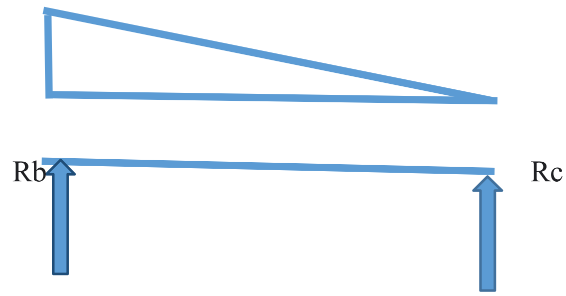


Fig-2(showingreactionduetocantileveraction)

- LoadintensityatCentralshaft2.78Kn/M=0.139 x 19
- TotalLoadontheSlabStrip=33.03Kn
- ReactionontheBeamend=Rb=20.68Kn
- ReactionatCentralshaft=Rc=12.35Kn

Check forshearatCentralshaftlocation:

- Shearcheckismadeatdistance"d"fromwallface
- Diameteratcriticalshear=1+2*0.2+2*0.1751.75M =1x1.7/7.2
- Widthofthesection0.24M
- Shear stress(d=15-4.5-0.5) 0.34 Mpa
- V= 0.34 Mpa

ReferTable61SP16

- Percentagerequired0.20%Concrete
- Grade M30
- Astrqd= 1.50Sqcm/M
- TotalSteelRequired8.25Sqcm
- Provided22nos-Y10at top&bottom

CheckforshearatBeamlocation:-

- Shear atthissection20.68KN
- B=100.00Cms
- d=17.5-4.5-0.512.50Cms
- ShearStress0.17Mpa
- NominalOK

2. Designofcentralshaft:-

- DesignforHoop forces:-
- Checkfor 1000dia section:-
- Criticalsectionatlevel138.35M
- Maximumwater Level146.60
- Waterheight8.25M
- ShaftDiameter 1.00M=8.25x10x1/2
- Hoopforce41.25Kn
- WallsectionProvided0.20
- M =41.25x1000/1000/200
- Stressdeveloped0.21Mpa
- NominalProvidedMinimumsteel0.35%Ast= 3.50Sqcm
- ProvidedY10-200C/CBothFaces

ForcesdevelopedatthekinkpointduetoverticalLoad:-

- Load fromcascadeaerator 279.25kn
- Load/Meter 88.89 kn/m
- Self-Loadofthe Shaft:-WallHeight8.25M
- Wallthicknessprovided 0.20 M
- WallLoad/Meter41.25kn/M
- TotalLoad/M130.14kn/m
- Say126.00Kn
- Horizontalforcedeveloped25.20Kn

Stress in steel=130Mpa

- Hoop forcedeveloped 13.86 Kn
- Astrqd1.07Sqcm
- Provided 2Nos 10Extra Both Face

Checkfor1Mdiasection:-

- Criticalsectionatlevel138.35M
- Maximumwater Level146.60 M
- Waterheight8.25M
- Shaft Diameter1.00M
- Hoopforce 41.25Kn
- WallsectionProvided 0.20 M
- Stressdeveloped0.21Mpa
- NominalProvidedMinimumsteel0.35%
- Ast=3.50Sqcm
- ProvidedhorizontalsteelY10-200C/CBothFaces

3).DesignofShaftasAnnularColumn:- Normal

Case:-

- ReactionfromtheAeratorSlab279.25 Kn
- (154.5-148.4)SelfLoadofthe Shaft:-H= 8.25M
- Self-loadoftheShaft=142.55 Kn
- TotalLoadontheShaft421.80Kn
- CompressiveStressDeveloped0.67Mpa
- NominalforM30Concrete,Provided Min.0.8%50.24 Sqcm
- SteelProvided50NosY12onBothFaces

Check for Seismic Case: - (56.5 Sqcm)

- SeismiczoneZoneII
- BasicseismicCoefficient 0.10
- ImportanceFactor 1.75
- PerformanceFactor 3.00
- Sa/gadopted2.50(maximum)
- DesignhorizontalSeismic coefficientasperCl6.4.2ofIS1893=0.07
- (duetoloadfromaerator)HorizontalForceatTop20.36Kn
- Horizontalforceself-Loadshaft10.39Kn
- WaterLoadintheShaft64.76 kn

- Horizontalforce duetowater4.72Kn
- Ht=8.25M
- B.Mduetoseismicforces117 kn-M
- say114.00kn-m
- Diameteroftheshaft1.00 M
- Ast=(fst=130)10.20Sqcm/M
- Totalsteel35.22sqcm
- Eachface17.61sqcm
- Provided 25.00 NosY12E.F

4) DesignoftheFoundationsfortheCentralShaft:-

- Loadingfromtheaerator=279.25Kn
- Loadingfromself-load centralshaft=142.55Kn
- Waterloadintheshaft=64.76Kn
- Foundationprovided
- L=1.80M
- B =1.80M
- Thickness=0.30M
- Self-LoadFooting=24.30Kn
- SoilLoadonfootingAreaonwhich loadisacting=2.46 Sqm
- Soilheight=2.15 M
- SoilLoadonfooting=95.01Kn
- TotalverticalLoad605.87=Kn
- say=593.00Kn

Allowable=310KN/Sqmat2mt.

- depthBase pressurenormalCase=183.02KN/Sqm
- SeismicMoment=135.1kn-m
- say=131.00kn-M
- Additionalbasepressure=134.77 KN/Sqm
- Maximumbasepressuredeveloped =317.80 KN/Sqm
- Minimumbasepressuredeveloped=48.25KN/Sqm(forseismiccase)
- Grossallowable=387.50KN/Sqm

- DesignVerticalpressure Max= 232.50KN/Sqm
- Maximumfooting offset=0.30M
- B.Minfootingascantilever=10.46kn-M
- Drequiredasuncrackedsection=177.16 MM
- Thicknessprovided=300.00MM
- Cover to steel=50.00MMBar
- Diameteradopted=12.00 MM
- d=244.00MM
- b=1000.00MM
- Mu/b/d/d=0.26Mpa
- Refertable4SP16,
- Fy500
- Pt=0.12
- Ast=292.80Sqmm
- Minsteelprovide=0.35%5.25Sqmm
- Ast provided=5.65Sqmm
- Providedat bottomY12-200C/CBbothwaysProvidedattopY12-200C/CT bothway

5) Designofconicalslab:-

- ProvidedThickness=175MM
- Lengthofslab=3MSlab
- Thicknessprovided=0.175 M
- DeadLoadoftheslab=4.375KN/Sqm
- Stepload=3.75KN/Sqm
- FloorFinishprovided50Th.=1.20KN/Sqm
- waterLoad3 KN/SqmTotalUDLonslab=W12.33KN/Sqm
- M=MaximumB.M=WL^2/813.866Kn-M
- Dprovided=175MM
- Coverto steel=40 MMBar
- Diameter=10 MM
- Effectivedepth=130 MM
- Mu=1.5xM20.79844Kn-M

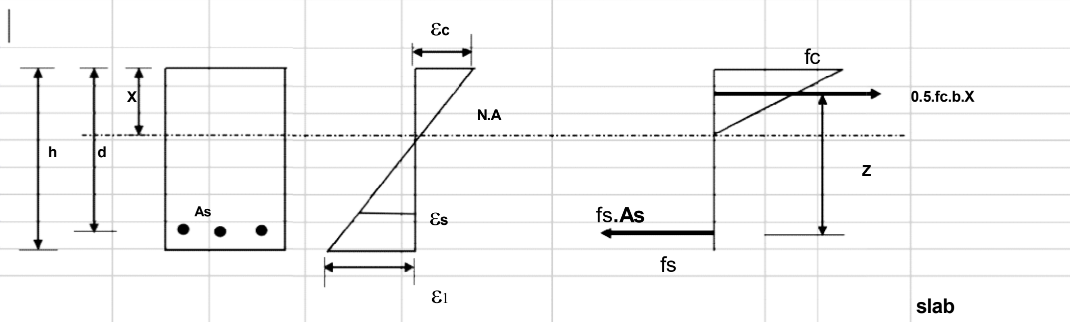
- Mu/b/d/d=1.2Mpa
- Aspertable 4SP16Fe500
- Pt=0.3160%age
- Ast=410.800Sqmm/M
- ProvidedT10-175 mm
- Ast.Provided=448.57Sqmm/M

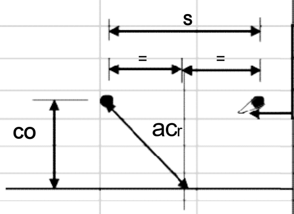
For hoop tension in conical slab =

=Ww+Ws/2x3.14+Wwx tana/2x3.14

- Wwwaterrestingonconicalslab=3Kn/m^2
- Wsselfwt.Ofslab= 8.25Kn/m^2
- Hooptension=4.636kn/m
- Ast.=35.659mm^2
- Ast.Ofeachface=17.83mm^2
- Henceprovided10dia@175c/cmidlayer
- ActualAst.= 2*1000*78.5/175= 1256.00mm^2
- Crackwidthofslab –

CRACKWIDTHFORFLEXUREEFFECT





GradeofConcreteUsed(fcu)	=	N/mm^2	30
GradeofSteelUsed(fy)	=	N/mm^2	500
AreaofReinforcement" As"	=	mm^2	448.57
WidthofSection b	=	mm	1000
DepthofSection h	=	mm	175
EffectiveDepthofSection"d"	=	mm	130
MinimumCovertoTensionReinforcement"CO"	=	mm	40
MaximumBarSpacing"S"	=	mm	175
BarDia	=	mm	10
"acr"=(((S/2)^2+(CO+DIA/2)^2)^(1/2)-DIA/2)	=	mm	93.39
DistanceFromthePointConsideredtotheSurfaceofNearestLongitudinalbar			
AppliedServiceMoment"Ms"	=	KNm	13.87
CALCULATION:			
ModuliofElasticity ofConcrete"Ec "=5000x(sqrt(fcu))=		KN/mm^2	27.39
ModuliofElasticity ofSteel"Es "=		KN/mm^2	200.00
Modular Ratio " α" = (Es/Ec)	=		14.61
"ρ"=As/bd	=		0.00345
α.ρ	=		0.05
DepthofNeutral Axis,"**X**"=d.α.ρ(((1+(2/α.ρ))^0.5)-1)	=	mm	35.24
Lever arm " Z" = (d - X/3)	=	mm	118.25
ReinforcementStress"fs"=Ms/(As*Z)	=	N/mm^2	261.40
ConcreteStress"fc"=(fs*As)/(0.5*b*X)	=	N/mm^2	6.66
StrainatSoffitofConcreteSlab"ε1"=(fs/Es)*(h-X)/(d-X)	=		0.00193
StrainduetostiffeningeffectofConcretebetweentheCracks "ε2"	=		0.00077
ε2= b.(h-X)2/(3.Es.As.(d-X))forCrack Widthof0.2mm			usednot
ε2= 1.5.b. (h-X)2/(3.Es.As.(d-X))forCrackWidthof0.1mm			used
AverageStrainforCalculationofCrackwidth"εm"	=		ε1-ε2
	=		0.00116
CalculatedCrackWidth,"W"=3.acr.εm/(1+2.(acr-CO)/(h-X))			
CalculatedCrackWidth"W "	=	mm	0.185

-
-

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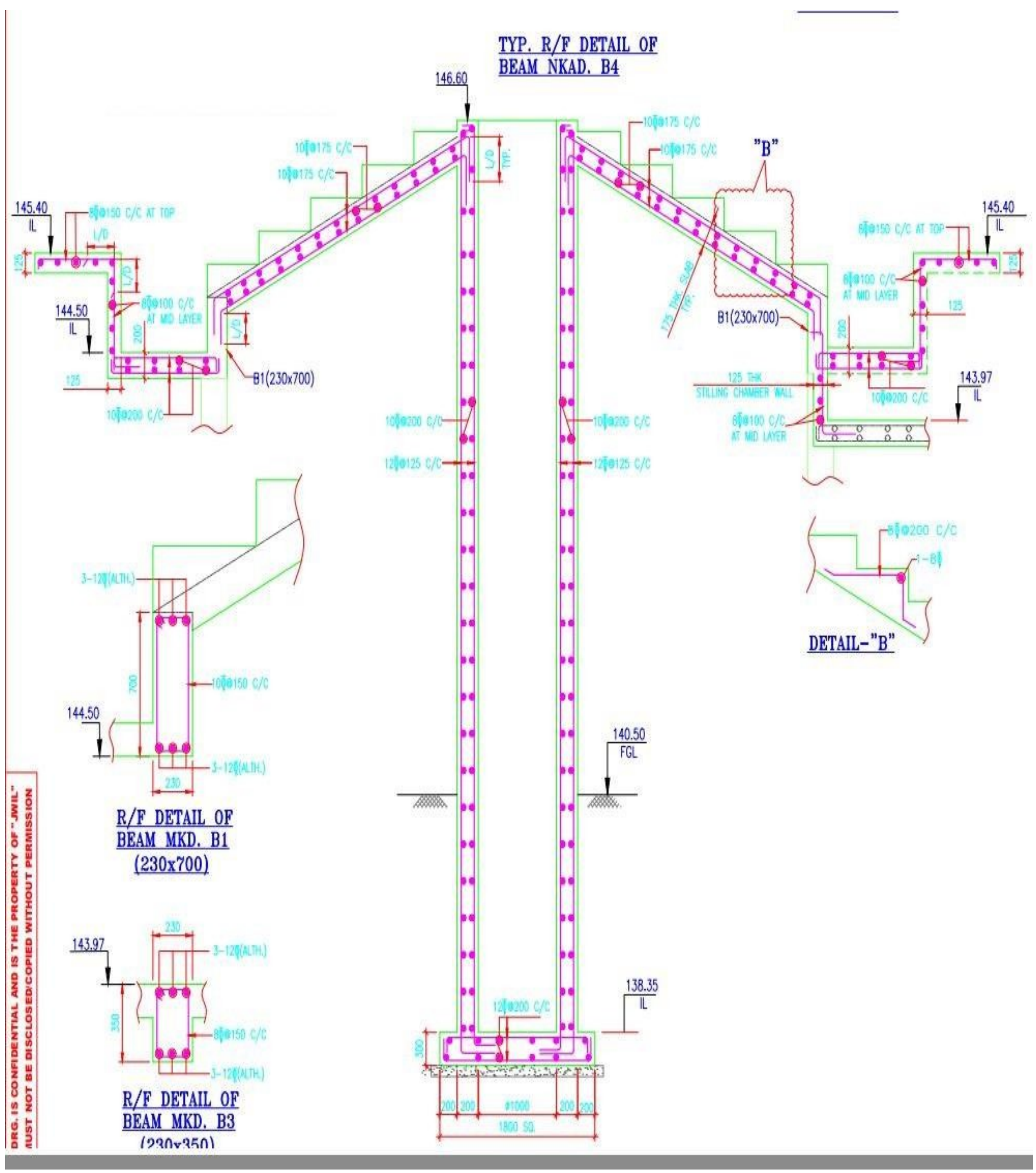
6) DesignofWalkway:-

Provided 125 MM

- ThickTotalwidthofwalkway=1M
- Clearspanofwalkway=1.0-0.125=0.875M
- Slabthicknessprovided= 0.125M
- DeadLoadofthe slab =3.125KN/Sqm
- Floor Finishprovided50Th.=1.20 KN/Sqm
- LiveLoad=3KN/Sqm
- TotalUDL walkway=W7.33KN/Sqm
- M=MaximumB.M=1x1xW/24.038Kn-M
- DepthProvided=125 MM
- (Tensionattop)
- Covertosteel=20MM
- BarDiameter=8MM
- Effectivedepth=101MM
- Mu=1.5xM=6.057Kn-M
- Mu/b/d/d= 0.6 Mpa
- Aspertable 4SP16Fe500
- Pt ofsteel%=0.1410%age
- Ast=142.410Sqmm/M
- Provided=T8mm-150c/c=335 Sqmm/M


TYP. R/F DETAIL OF
BEAM NKAD. B4
146.60
145.40
IL
144.50
IL
B1(230x700)
"B"
143.97
IL
DETAIL-"B"
R/F DETAIL OF
BEAM MKD. B1
(230x700)
144.50
140.50
FGL
138.35
IL
143.97
R/F DETAIL OF
BEAM MKD. B3
(230x350)

Conclusion

As a conclusion we have the RCC structure details for the different small units contain cascade aeratorwe are able to decide the RCC quantity as well assteel quantity consumed by the particular units of the cascade system which is the finals AIM of this paper summaryof the design are mentioned below ,Design parameters Base slab of cascade aerator - HorizontalSpan =2.90 M (Refer Dwg.), Slope of The Slab=63.00 , Diameter at Centralshaft location 1.00 M ,Provided 22nos- Y10 at top& bottom, B= 100.00 Cm, d=12.50 cm, Design oftheFoundationsfortheCentralShaft:-Foundationprovided,Length1.80M,Breadth =1.80 M, Thickness 0.30 M, Provided at bottom Y12-200C/C B both ways provided at top Y12-200C/C T both way.

Design of Conical slab includes, Length of slab= 3 M Slab, Thickness provided= 0.175 M, D provided= 175 mm, Cover to steel=40 mm Bar, Provided T10-spacing 175 mm.

Design parameters outputs forthe ofwalk way includes Thick Totalwidth ofwalk way= 1 m,Depth provided= 125 mm,Cover to steel = 20 mm,Bar Diameter = 8 MM, Effective depth= 101 mm,Pt ofsteel% = 0.1410 %age, Ast= 142.410 Sqmm/m ,Provided =T8mm-150 c/c =335 Sqmm/M.

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