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Design and analysis of water pumping station

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Abstract-The main objective of this work is to design and analyze. The water pumping station for Orange city water Pvt. Ltd. Gorewada. The existing pumping station is nearly out of service. This is installed in 1930, this is having many problems such as reduced water head due to leakages, rusted pipe surfaces, and also the design is outdated. The current work mainly aims at design/Analysis of pumping station. The cad model of pumping station is developed using Triflex software. Also, structural analysis is performed in the same software. On the basis of result obtained in software design modification are suggested.

1. INTRODUCTION

The OCW Gorewada water treatment plant collect water from Gorewada Lake & sewer filter water. Water treatment plants filter water & supply to the seminary hills or distribution network.

The components of the pumping stations as follows,

A. Centrifugal pump: - A centrifugal pump is high head, high efficiency, smooth flow rate, easy in operation & maintenance. The pump existing specification are Total head: - 85 m, Discharge: - 455 m^3/s, Pump input: - 135.570 m/s, Pump efficiency: - 77.69 %, Motor: - 180 kW, Speed: - 1488 rpm, NPSH (Net positive suction head):- 2.18 m, Specific gravity: 1000 kg/cm^2 , Material constant code: - 40,Impellerdia.:- BR/497 mm, Suction size: - 200 mm, Delivery size: - 150 mm, Freq: - 50 5 %

B Butter fly valve: - A Butterfly Valve is used to control the flow of material through a circular pipe or tube. Its specification shown in table no.1

c. Non return valve: - Non return valve prevent reverse flow & protect pump from excessive back pressure. Its specification shown in table no.1

D. Gate valve: - Gate valve either used fully closed or fully open never used to control flow of water. Its specification shown in table no.1

TABLE 1

A.1.1. Compon- A.1.2. ents	A.1.3. N A.1.4. mm)	A.1.5. theoretical weight (kg)	A.1.6. ae-rial	A.1.7. ressure
A.1.8. Butter fly valve	A.1.9. 00	A.1.10. 83	A.1.11 I	A.1.12. N-10
A.1.13. Non return valve	A.1.14. 00	A.1.15. 230	A.1.16 I	A.1.17. N-10
A.1.18. Gate valve	A.1.19. 00	A.1.20. 160	A.1.21 I	A.1.22. N-10

E. Flanges: - Flanges are use to connect valves & pipes by nut & bolt. Packing is provided to prevent leakages. Its specification shown in table no.2

TABLE-2

1.23. a- 1.24. le	1.25. lan ge dia.	1.26. C D	1.27. F olts	1.28. B oltsi ze	1.29. H ole size	1.30. T hikn ss	1.31. M ateri al
1.32. S 4 5 0 5- 1 6	1.33. 40 mm	1.34. 70 m m	1.35. 2 0	1.36. M 33	1.37. 3 6m m	1.38. 4 8m m	1.39. G rey CI

F. Reducer & Expander

An eccentric reducer & concentric expander are used in piping systems between two pipes of different diameters. Eccentric reducers are used at the suction side of pumps to ensure air does not accumulate in the pipe. Its specification shown in table-3.

TABLE 3

1.40. Com ponent	1.41. In put dia.	1.42. Out put dia.	1.43. L ength	1.44. T hickn ess
1.45. Redu cer	1.46. 30 0 1.47. mm	1.48. 200 1.49. m m	1.50. 1 75 mm	1.51. 1 5mm
1.52. Expa nder	1.53. 15 0 mm	1.54. 300 mm	1.55. 1 75 mm	1.56. 1 5mm

The working of pumping station is usually the transport of water from storage facilities to distribution networks takes place through pressurized pipelines. The pressure is created either through gravity or through associated pumping stations. The water is moved from source (such as dams) to water treatment plants and then (usually) pumped into service reservoirs and distribution networks to homes and businesses. As shown in fig.no.2 typically water transmission pipelines are constructed using concrete pressure pipes, ductile iron pipes, steel pipes or GRP/GRE pipes. At the lower end of the dimensional range plastic pipes (such as HDPE) may be used.

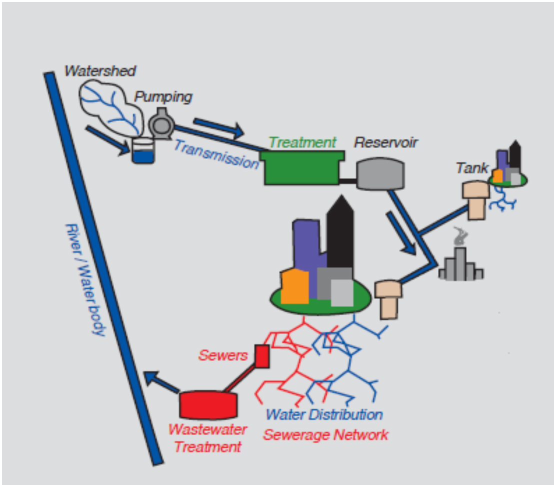

Fig.no.2 water transmission pipe lines

The reason of choosing this project is its pump, valves and pipelines are old, due to which required discharged pressure doesn't obtained as well as maintenance is required. Therefore we design new water pumping station pipe lines.

2.LITERATURE REVIEW

According to Laszlo E. Kollár, Rakesh Mishra, and Taimoor Asim. The repair cost of pipe and cost of pumping power increase as the pipe becomes older due to more frequent pipe breaks and due to the pipe wear that makes wall roughness, and thereby pressure drop, greater. According to Salah El-Din Sayed Mohamed Increasing the corrosion rate leads to the failure of the pipeline, low values of soil resistivity increase the corrosion rate rapidly. Technical data including the material of pipelines and operating conditions were collected. According to N. Ursinoa*, P. Salandina Pump failure is defined as the inability of the pump to pump at design capacity. However, the system failure may be due to an unexpected rainfall event exceeding the overall design capacity of the pumps, or to the failure of one or more pumps being the inflow to the pumping station less than the design capacity. According to Peter J. Baker These will use true maximum loads to select the appropriate components, rather than a notional factor of the mean operating pressure. This will lead to safer designs with less over-design, guaranteeing better system control and allowing unconventional solutions such as the omission of expensive protection devices. It will also reveal potential problems in the operation of the system at the design stage, at a much lower cost than during commissioning.

3. METHODOLOGY

- 2D layout of pumping station using Auto-cad.
- 3D model of pumping station using triflex software.
- Structural analysis of pumping station.
- Result interpretation.

Proper design of suction piping is important to minimize pressure losses and allow sufficient flow into the pump. Suction piping should be as short as possible as but never smaller than pump suction opening. Suction elbows to avoid high unequal zed thrust loads that will overheat bearings and cause undue wear as well as affecting hydraulic performance, Suction pipe will slope upward to the pump connection when operating on suction lift. If the discharge pipe is short, the diameter of the pipe will be same as pump discharge nozzle. If the discharge pipe is long, the diameter will be increased by one or two sizes depending on length. Consider above design criteria, the pumping station layout is design. Details of diagram with dimensions as shown in fig no.3

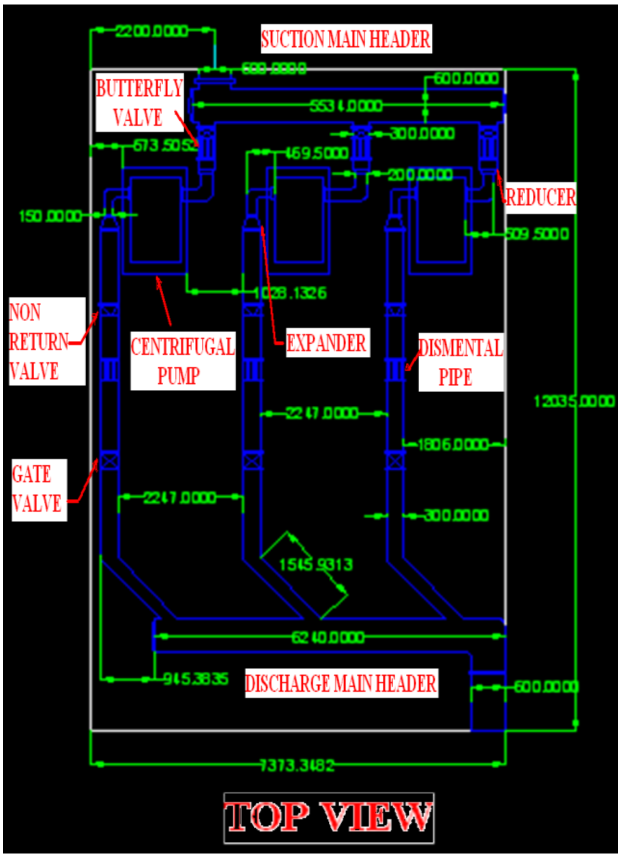

Fig.3 top view of pumping station layout

The triflex is pipe stress analysis software. Valves icon is available & graphics is good as compare to other stress analysis software. Is used for 3D layout & analysis purpose. 3D model of suction pipes as shown in fig.no.4. The water fetches from tank to suction main header & then flow to pump, through butter fly valve & reducer. The dia. Of Suction main header is 600 mm & pipe dia. is 300 mm.

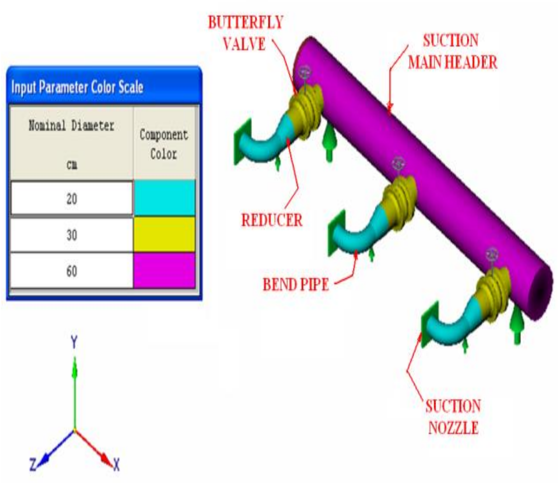

Fig.4 Geometric Plot of Suction Pipes

3D model of Discharge pipes as shown in fig.no.5. The water fetches from suction main header to discharge pipe by centrifugal pump & centrifugal pump to discharge main header. The dia. of discharge pipe is 300 mm & main header dia. is 600mm.

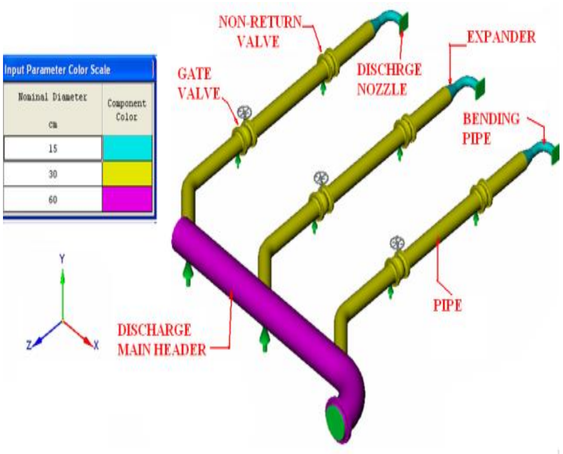

Fig.5 Geometric plot of discharge pipes

Plant specification of structural analysis of 3D model is proposed for analysis purpose selected. So as to check the viability of proposed design for static self loading condition in real time. The pipe will be selected to self weight & weight of fluid flowing inside.

Initially no support is provided along overall length of pumping station. Hence, boundary condition selected for initial analysis purpose as are follows. Shown in table no.4

TABLE-4

Parameter	**unit**	**pump discharge**
Fluid	-	Water
Piping code	ANSI/ASME	B31.3
Fluid temperature, t_f	^oC	28
Ambient temperature, t_a	^oC	21
Discharge pressure, p_d	KG/CM2 G	7.8
Suction pressure, p_s	KG/CM2 G	0.49
Material specification	ASTM	ASTM A 36

On the basis of result obtained for discharge pipes as shown in fig.no.6 & table no.5

TABLE NO. 5

A.1.57. tres ses	A.1.58. allowed stress	A.1.59. without support	A.1.60. ith sup por t
A.1.61. (kg /cm 2)	A.1.62. 125 1	A.1.63. 52 08.5	A.1.64. 24. 9
A.1.65. stress (%)	A.1.66. 187 6	A.1.67. 41 6	A.1.68. 0

Observing above table, for discharge pipes we get actual sustained stress are 5208.5 and allowed stress are 1251, it means there are more number of chances of failure. Therefore we provide support to the pipes and getting safe design stress which is lower than upper critical point.

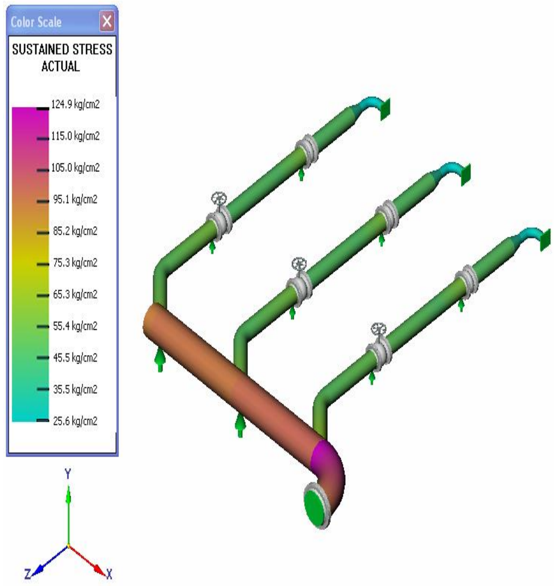

Fig.6 with support actual sustained stress for discharge pipes

The result obtained for suction pipe

TABLE NO. 6

A.1.69. stresses	A.1.70. allowed stress	A.1.71. without support	A.1.72. with suppose
A.1.73. Actual sustained stress (kg/cm2)	A.1.74. 1251	A.1.75. 314.8	A.1.76. 19.1
A.1.77. Sustaned stress (%)	A.1.78. 1876	A.1.79. 25	A.1.80. 2

Observing above table, for suction pipes we get actual sustained stress are 314.5 and allowed stress are 1251, it means there are no chances of failure. But for future safety we provide support to the pipes and getting safe design stress which is lower than upper critical point

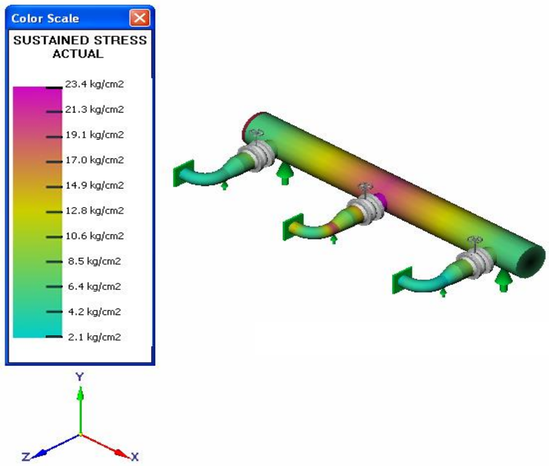

Fig.6 with support actual sustained stress for Suction pipes

4. CONCLUSION

It is observed that the stress at bend of pump discharge pipe is crossing the safe limit. Hence, the design modification is suggested in which the support location are decided and reanalyzing the suggested design. It is observed that the critical areas of discharge pipe line are well below the safe stress limit. Hence it is concluded that of proposed structural design of pumping station is safe and can be implemented in real time.

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