International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

ANALYSIS AND DESIGN OF SEDIMENTATION TANK

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ABSTRACT :

Making sure everyone has access to clean water, whether for drinking or other uses, is a top priority. That can't happen unless we purify the water before giving it to them. Our primary objective is to purge the provided raw water of any suspended particulates. Researchers in the town of Motadaka (Guntur), which is home to around 5,000 people, studied the settling properties of raw water in a purpose-built settling tank. The Sedimentation Tank was designed and analyzed using STAADpro V8i software. In this case, the tank's height and radius are determined by hand. Based on the capacity of 250 m3, which is 5.2 m, and the expected height of 3 m, we have calculated the radius of the tank. The tank undergoes dead load and hydro-static load analysis using the limit state approach, which is triggered by water. For this sedimentation tank's study and design, we looked to IS 456-2000 and IS 875-2007, section 1 for dead loads and section 2 for hydrostatic loads. Based on this, we have used STAAD pro to create a circular tank for sedimentation. Important terms: hydrostatic loads, sedimentation tanks, STAAD pro, and tank characteristics.

1.0 INTRODUCTION

Before using further purification procedures, such filtration or disinfection, sedimentation is suggested as an easy and inexpensive way to pre-treat water. It uses gravity to filter out biological pollutants and unwanted suspended particles including sand, silt, and clay.

Additionally, it enhances the water's aesthetics and makes it more appealing to customers. The longer sediment settles in water, the more germs and suspended particles sink to the bottom. In order to prepare water for further purification processes, sedimentation is a straightforward and inexpensive pre-treatment technique that uses gravity to remove settable solids and some bacteria. In addition to treating highly turbid raw water during the rainy season, pre-sedimentation significantly reduced solids loadings, including larger particles, in the water treatment plant, which improves the water's visual qualities and increases its acceptance by consumers (Kwak et al., 2010). It is possible to sequentially treat raw water in order to eliminate contaminants. High pollutant removal efficiency is highly dependent on the selection and organization of various treatment methods.

The quality of the raw water determines the final product water, and pre-sedimentation affects the functioning of the water treatment plant in many ways. We need optimization. The goal of optimizing a traditional drinking water treatment plant is to increase the efficacy of the treated water by "achieving the most efficient or effective use" of the plant in accordance with certain guidelines. Continuously high-quality finished water is an accomplishment, and the necessity of concentrating on the plant's total performance should be emphasized. Pre Sedimentation Tanks (PSTs) are a known source of trouble for water treatment facilities, according to studies. The effectiveness and efficiency of the sedimentation tank may affect the concentration and properties of the suspended particles. Despite the fact that PST reduces turbidity, water with low turbidity becomes "tough," making it difficult to treat in following stages of water treatment plants. Additionally, it is not always the case that increasing the turbidity of raw water leads to an improvement in the effectiveness of turbidity removal.

An important part of treating water and wastewater is a sedimentation tank, which is sometimes called a settling tank. Its purpose is to filter out solids in liquids by letting the heavier particles sink to the bottom as a result of gravity. Municipal and industrial treatment facilities often use sedimentation tanks to enhance the water quality prior to processing or discharge. Overflow velocity, flow through velocity, detention duration, and tank size are some of the design elements that control this crucial process. Producing clean, clarified water for a variety of uses relies on a sedimentation tank operating efficiently. Sedimentation tank material selection is challenging since it must take the treated environment's water and chemicals into account. The structural integrity under extreme hydrodynamic loads and mechanical intricacies depends on the material strength. The total economic effectiveness of the project is significantly affected by the cost and the capability of re-cycling materials. There is hope for the future of sedimentation tanks and their use in a range of climates thanks to the creation of novel composite materials with enhanced resistance characteristics and mechanical capabilities. The removal of solid particles from water is an essential function of sedimentation tanks in the functioning of hydroelectric power plants (HPPs). There are a number of significant benefits to this procedure. Turbines may last longer and have less wear and tear if solid particles are removed from the water. When suspended materials like sand or silt get into a hydroelectric power plant's system, they may cause significant damage to the turbines.

1.1 TYPES OF SEDIMENTATION TANKS

1.1.1 Circular Tanks: In plain sedimentation, these are generally not used but in sedimentation, with coagulation, they are mostly used. On the basis of the flow of water there are two types of circular sedimentation tanks

Fig-01 – Circular Sedimentation Tank

1.1.2 Hopper Bottom Tanks: Sedimentation tank material selection is challenging since it must take the treated environment's water and chemicals into account. The structural integrity under extreme hydrodynamic loads and mechanical intricacies depends on the material strength. The total economic effectiveness of the project is significantly affected by the cost and the capability of re-cycling materials. There is hope for the future of sedimentation tanks and their use in a range of climates thanks to the creation of novel composite materials with enhanced resistance characteristics and mechanical capabilities. The removal of solid particles from water is an essential function of sedimentation tanks in the functioning of hydroelectric power plants (HPPs). There are a number of significant benefits to this procedure. Turbines may last longer and have less wear and tear if solid particles are removed from the water. When suspended materials like sand or silt get into a hydroelectric power plant's system, they may cause significant damage to the turbines.

Fig-02 –Hopper Bottom Sedimentation Tank

1.1.3 Fill and Drawn Sedimentation Tank: In this sort of system, the water that enters the tank is held for a period of time, often about 24 hours, during which the dispersed particles settle to the tank bottom. The water is released via the outlet after twenty-four hours. In a fill-and-draw-type sedimentation tank, a single sedimentation operation takes 30 to 40 hours, since the settled particles must be removed after 6 to 12 hours.

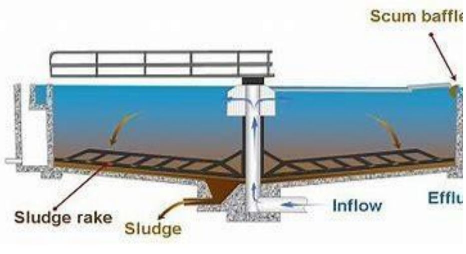

Fig-03 – Fill and Drawn Sedimentation Tank

2.0 LITERATURE REVIEW

There has been, basically, a general tendency to construct the limit sales of the structure to modify such occurrences, according to Mahesh Tandon's (2005) assessment of each actual earthquake. New approaches have been adequately state-of-the-art in dealing with this problem financially just in the last ten years. Modern best practices have shifted towards a showcase-based structural design, with an emphasis on practicality and success in the face of varying degrees of seismic monsters. In addition, he considered that there is a level of control that is desired for seismically safe developments, whether it be "passive" control via supported indicating structures or "active" control by express devices. Implementing these considerations sensibly may inspire development structures that are both modest and safe.

Publication Date: April 20, 2024 Issue Number: 2102 Journal Article Number: 23661313

Y. Vinod Kumar and Dr. Chava Srinivas (2015) used computational methodologies such as Grillage evaluation and Finite part approach to introduce a comprehensive evaluation of box course. Grillage evaluation is flexible enough to be used to a wide range of system decks with varying degrees of complexity and clarity. The software STAAD Pro is often used for grillage evaluations. Their primary objective was to determine the degree to which shear force and bowing second characteristics were influenced by the direction of box funnels and stress groups.

Lande Abhijeet Chandrakant, Patil Vidya

Malgonda (2014) saw that partner plan of box pipe consolidates thought of weight cases and factors like live weight, productive width, dispersal of weight through fill, impact factor, co-equipped for earth pressure, and so forth. All auxiliary pieces must be designed to resist the strongest shear and most unusual bending moments. In order to separate the evaluation and programming outcomes, an outperform wants program is created. Consequently, it needs an evaluation of its box course for various box situations, and a fundamental case strategy is suggested.

Anjithan, 2016; Crittenden et al., 2012; USEPA, 2011.

Contaminants such as bacteria, inorganic and organic pollutants, and surface water (rivers and reservoirs) and groundwater (aquifers) may be found in raw water. Algae, colloids, organic and inorganic materials, dissolved solids, turbidity-causing solids, microorganisms, and both naturally occurring and artificially added solids via chemical treatment or precipitation of the original water are all examples of pollutants. By filtering out contaminants from both the raw water and the different chemicals used to treat it, most surface water treatment plants create massive amounts of sludge. These plants typically use traditional treatment methods like coagulation, flocculation, sedimentation, filtration, aeration, and disinfection.

Ippolito et al., (2011). Many different by-products, including liquid, solid, semisolid, and gaseous phases, are created during the water treatment operations that ensure the water is safe to consume. The raw water supply, treatment chemicals, and unit activities utilized determine the sorts of residuals. The water authorities are under a lot of pressure to find a way to treat and dispose of sludge safely since people are more worried about the environment. Choosing an appropriate, technically sound, and economically viable sludge treatment and disposal method is crucial.

(Crittenden et al., 2012). Improved treatment, disposal, and prevention/control of release of source water treatment sludge into the environment are often achieved via the use of innovations and current management practices used by water treatment facilities (WTPs). It is possible that WTPs would greatly improve their chances of meeting the permitted limitations if they used certain innovative and current management practices. Reducing energy usage, operating costs, and improving water quality are just a few of the many benefits of new technologies and contemporary management approaches in the water treatment industry (USEPA, 2011). Considerations like as volume, handling costs, composition, and compliance with environmental and regulatory standards make sludge management an essential component of any water treatment system.

3.0 METHODOLOGY

3.1 SOFTWARE OVERVIEW:

One of the most well-known and extensively used structural analysis and design applications is STAAD Pro. Buildings, bridges, towers, and countless more kinds of structures may be analyzed and designed with the help of this all-inclusive suite of tools and features developed by Bentley Systems. Countless engineering experts all around the globe rely on STAAD Pro due to its user-friendly interface and powerful analytical features.

3.2 STEP TO STEP PROCESER

3.2.1 Create or Import Geometry The next step is to use STAAD Pro's in-built modelling tools to draw or import the geometry of the building you want to study. Several input formats are compatible with the program, so you may bring in models from well-known CAD programs or swap files with others.

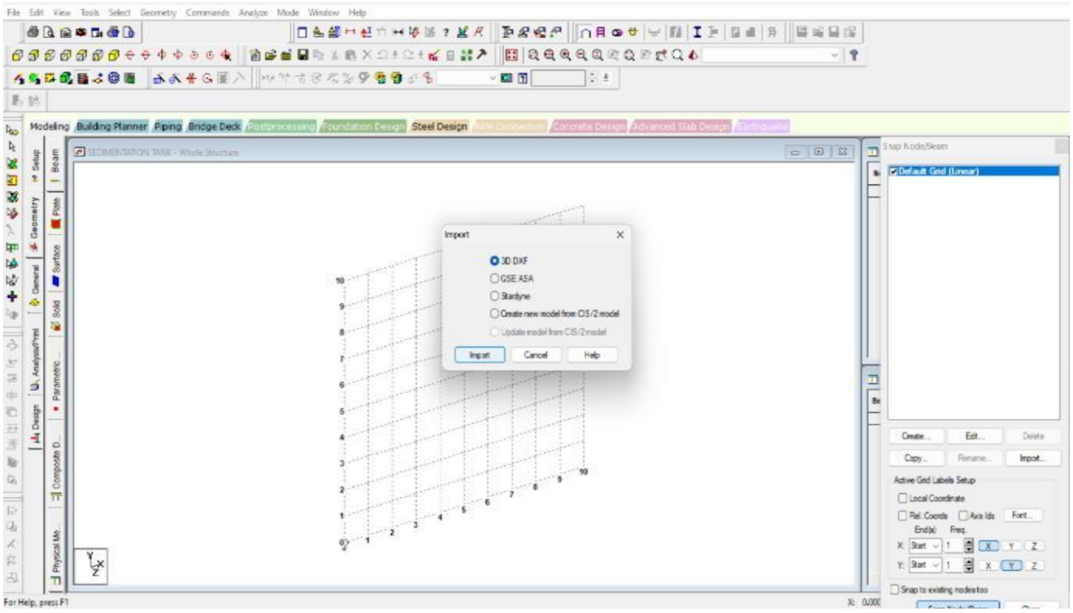

Fig-03– Importing Files

3.2.2 Define Material Properties Detail the characteristics of the various structural components' materials, including concrete, steel, and wood. Give the necessary mechanical characteristics of the material, such as its strength and modulus of elasticity.

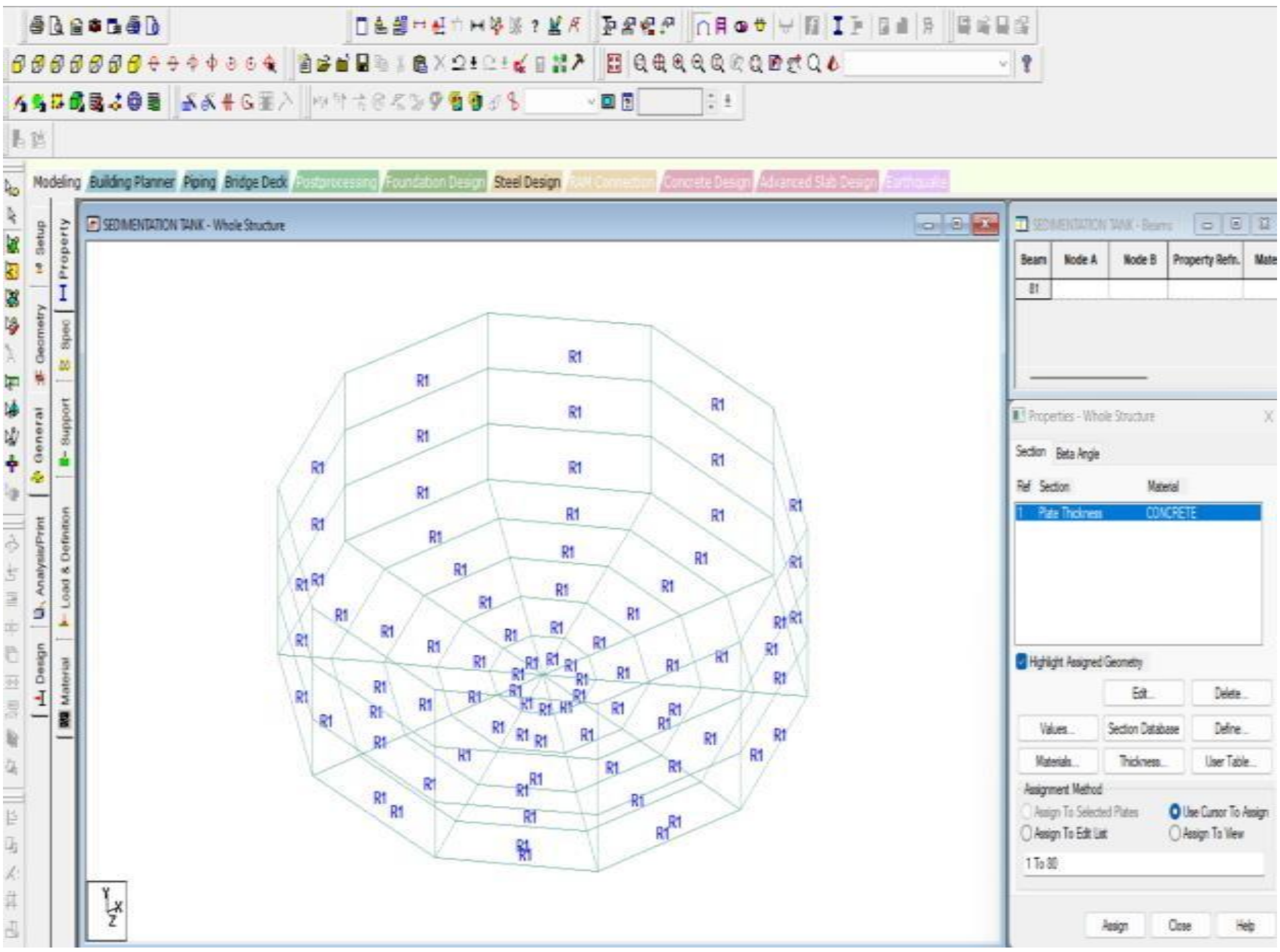

Fig-04 – Material Properties

3.2.3 Supports Generate and Assign Assistance Dependent on Repair Status

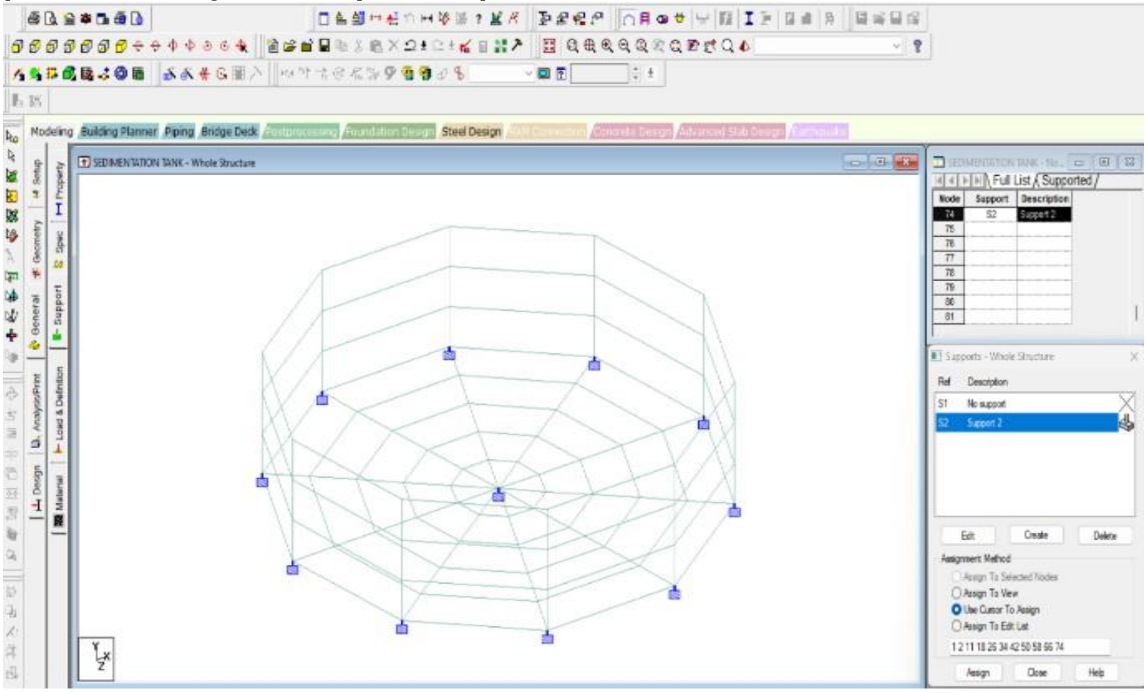

Fig-05 – Supports

3.3.5. Use Amounts Take into account the design requirements and load combinations while applying the appropriate loads to the structure. Dead loads, live loads, wind loads, snow loads, and many more are all available in STAAD Pro. Make that the geometry of the model is properly loaded.

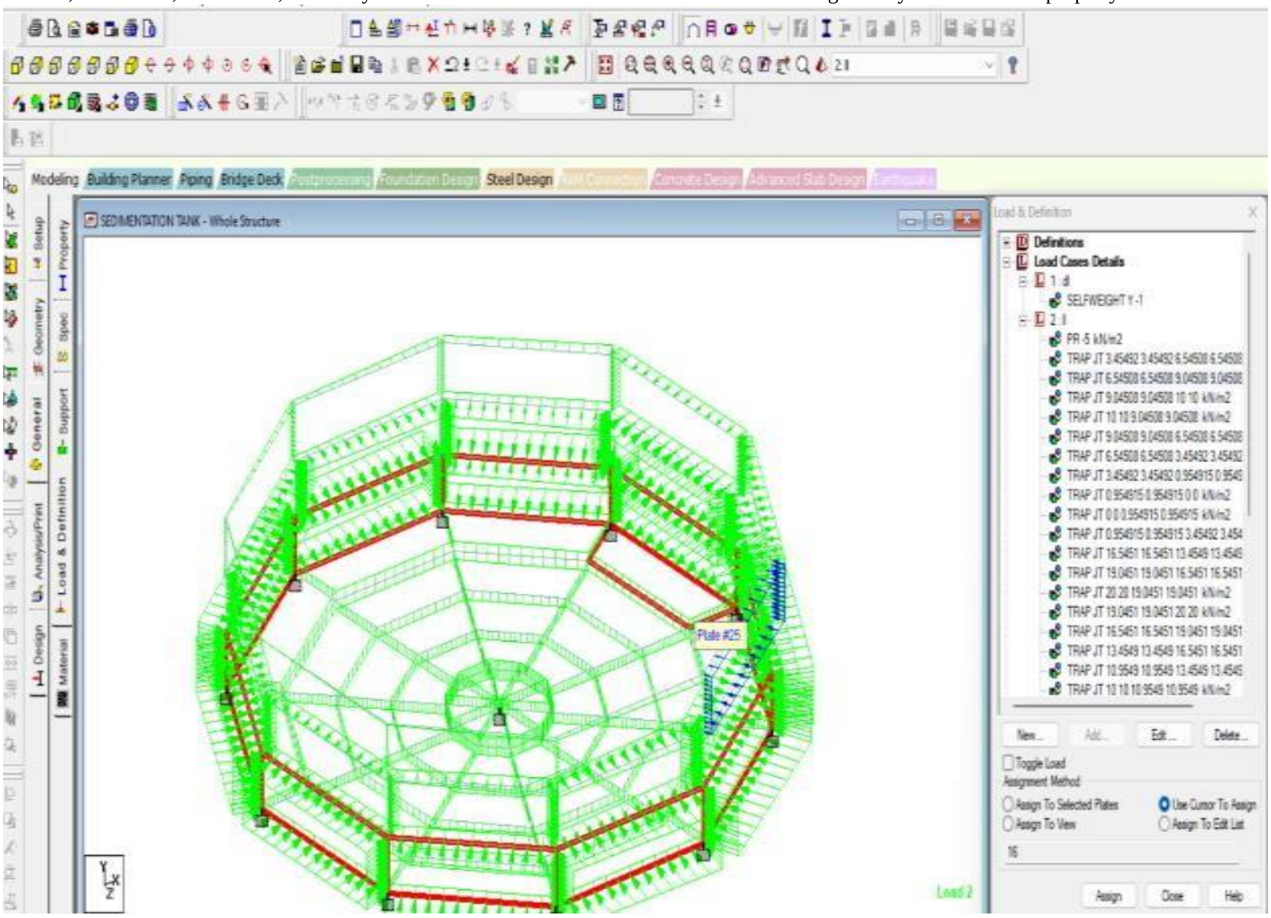

Fig-06 – Loads

4.0 RESULTS

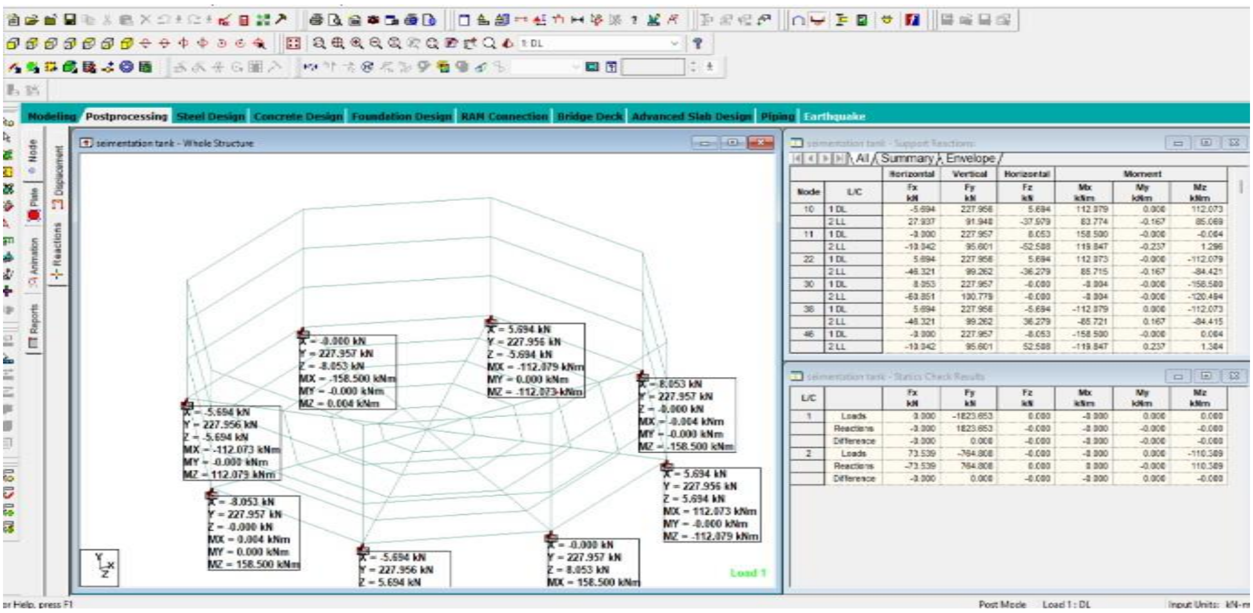

Fig-07 – Support Reactions

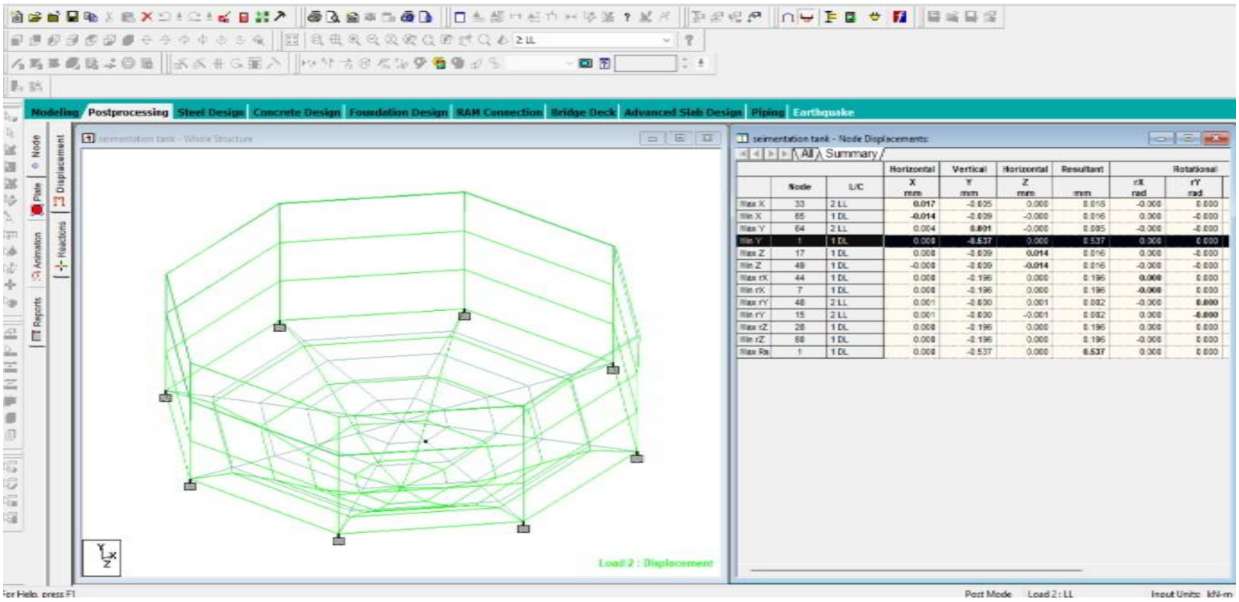

Fig-8 – Maximum Displacement

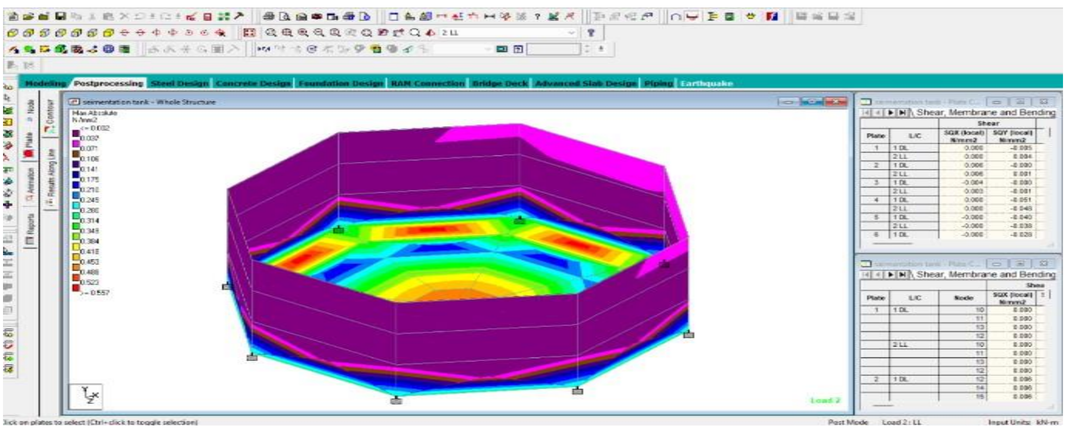

Fig-9 – Maximum Absolute Pressure

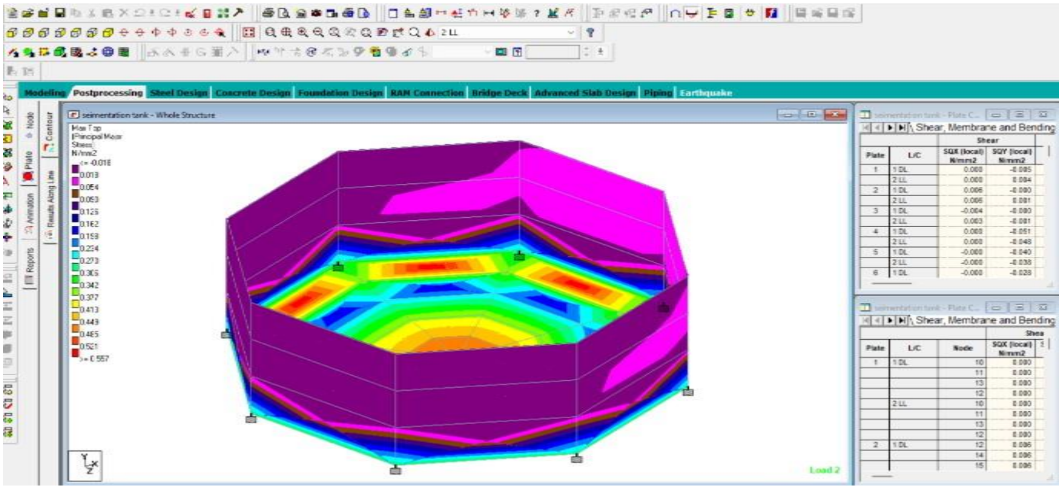

Fig-10 – Maximum Top Major Principle Stress

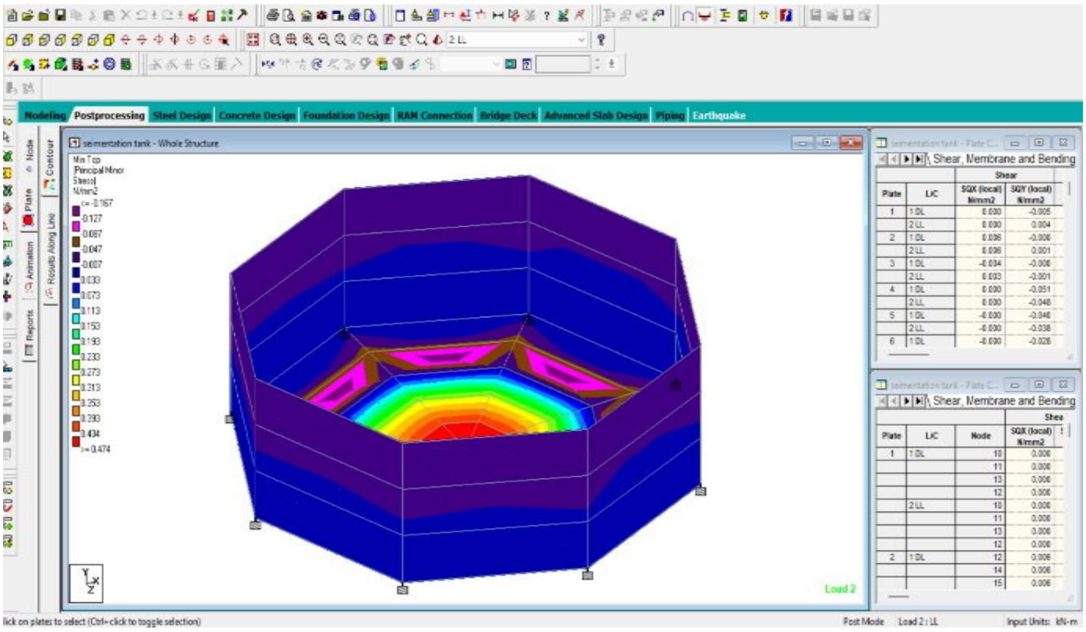

Fig-11– Maximum Top minor Principle Stress

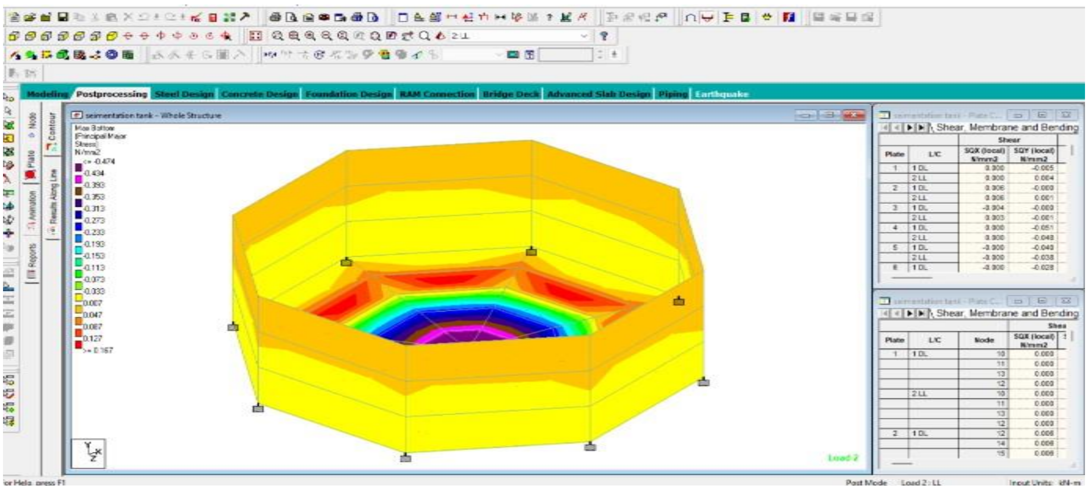

Fig-12 – Maximum Bottom Major Principle Stress

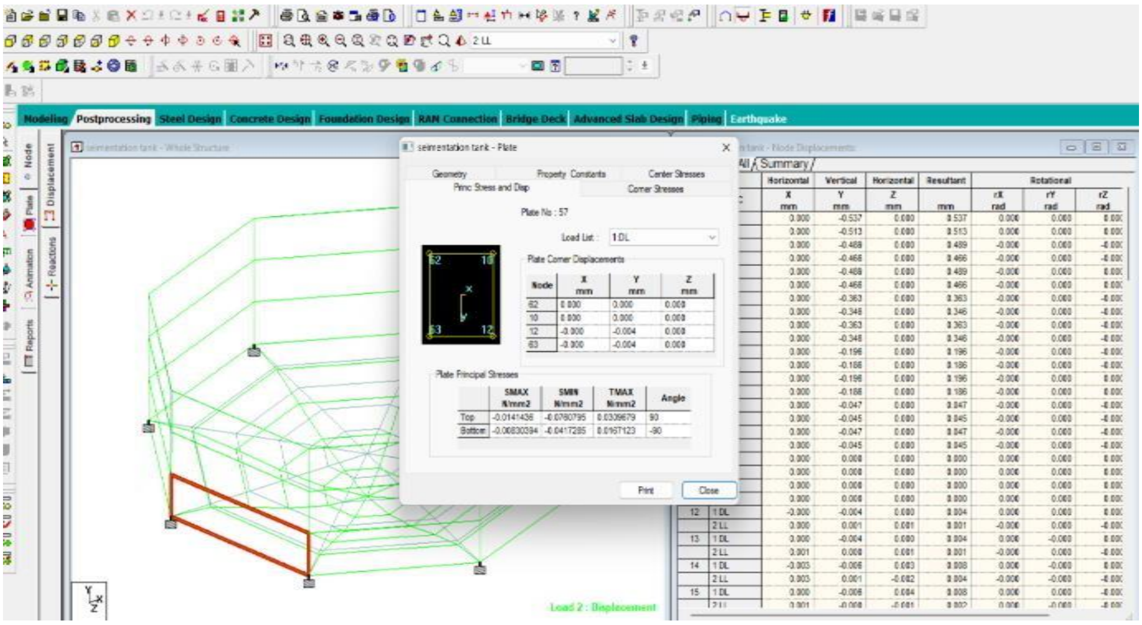

Fig-13 – Principle Major Stresses and Displacement Plate No 57

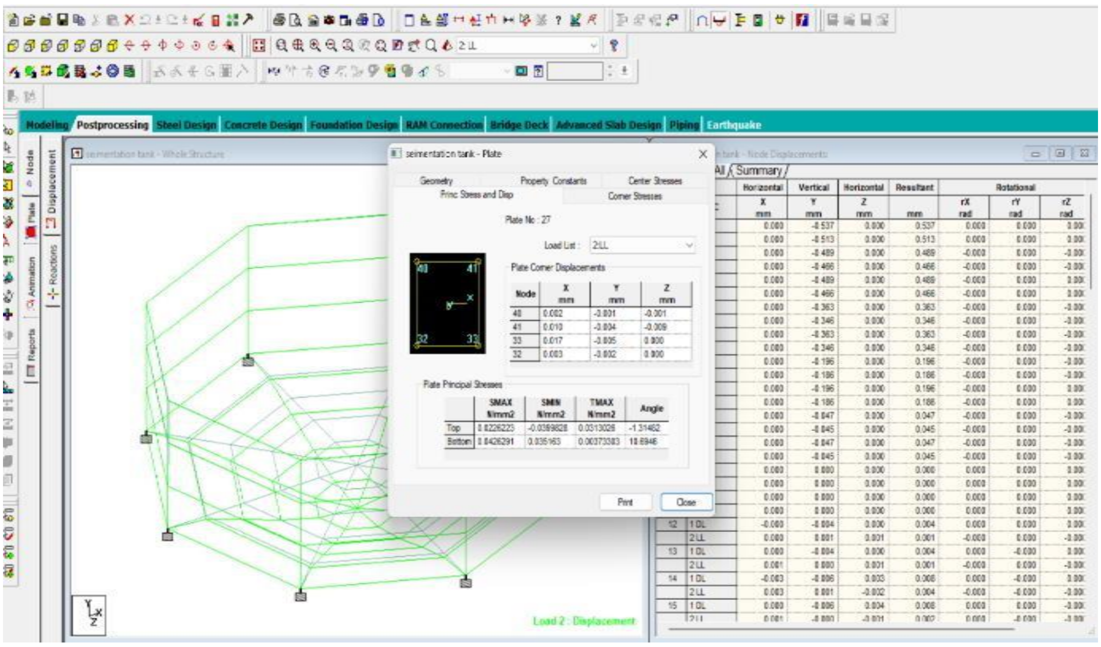

Fig-14 – Principle Major Stresses and Displacement Plate No

17 TOP :	516.	0.00 / 0	516.	0.00 / 0
BOTT:	516.	-0.10 / 1	516.	-0.58 / 1
18 TOP :	516.	0.90 / 2	516.	0.13 / 2
BOTT:	516.	0.00 / 0	516.	0.00 / 0
19 TOP :	516.	0.00 / 0	516.	0.00 / 0
BOTT:	516.	-1.39 / 2	516.	-0.22 / 2
20 TOP :	516.	0.98 / 1	516.	19.77 / 1
BOTT:	516.	0.00 / 0	516.	0.00 / 0
21 TOP :	516.	0.00 / 0	516.	5.38 / 1
BOTT:	516.	-5.92 / 1	516.	0.00 / 0
22 TOP :	516.	11.17 / 1	516.	5.46 / 1
BOTT:	516.	0.00 / 0	516.	0.00 / 0
23 TOP :	516.	12.90 / 1	516.	14.35 / 1
BOTT:	516.	0.00 / 0	516.	0.00 / 0
24 TOP :	516.	16.67 / 1	516.	16.67 / 1
BOTT:	516.	0.00 / 0	516.	0.00 / 0
25 TOP :	516.	0.00 / 0	516.	0.00 / 0
BOTT:	516.	-0.10 / 1	516.	-0.58 / 1
26 TOP :	516.	0.90 / 2	516.	0.13 / 2
BOTT:	516.	0.00 / 0	516.	0.00 / 0
27 TOP :	516.	0.00 / 0	516.	0.00 / 0
BOTT:	516.	-1.39 / 2	516.	-0.22 / 2
28 TOP :	516.	0.98 / 1	516.	19.77 / 1
BOTT:	516.	0.00 / 0	516.	0.00 / 0

Fig-15 – % of Steel Details in Plates

40 TOP :	516.	16.67 /	1	516.	16.67 / 1
BOTT:	516.	0.00 /	0	516.	0.00 / 0
41 TOP :	516.	0.04 /	2	516.	0.26 / 2
BOTT:	516.	-0.10 /	1	516.	-0.58 / 1
42 TOP :	516.	0.79 /	1	516.	0.13 / 1
BOTT:	516.	0.00 /	0	516.	0.00 / 0
43 TOP :	516.	0.00 /	0	516.	0.00 / 0
BOTT:	516.	-0.89 /	2	516.	-0.16 / 2
44 TOP :	516.	0.98 /	1	516.	19.77 / 1
BOTT:	516.	0.00 /	0	516.	0.00 / 0
45 TOP :	516.	0.00 /	0	516.	5.38 / 1
BOTT:	516.	-5.92 /	1	516.	0.00 / 0
46 TOP :	516.	11.17 /	1	516.	5.46 / 1
BOTT:	516.	0.00 /	0	516.	0.00 / 0
47 TOP :	516.	12.90 /	1	516.	14.35 / 1
BOTT:	516.	0.00 /	0	516.	0.00 / 0
48 TOP :	516.	16.67 /	1	516.	16.67 / 1
BOTT:	516.	0.00 /	0	516.	0.00 / 0
49 TOP :	516.	0.07 /	2	516.	0.40 / 2
BOTT:	516.	-0.10 /	1	516.	-0.58 / 1
50 TOP :	516.	0.79 /	1	516.	0.13 / 1
BOTT:	516.	-0.05 /	2	516.	0.00 / 0
51 TOP :	516.	0.00 /	0	516.	0.00 / 0
BOTT:	516.	-0.76 /	1	516.	-0.14 / 2

Fig-16 – % of Steel Details in Plates

5.0 CONCLUSION

Water treatment facilities may face significant challenges when attempting to remove very turbid water. Water pretreatment for turbidity rates more than 400 NTU is an essential yet challenging subject covered in this study. A series of laboratory experiments are conducted to examine the effect of baffle height and location on the performance of sedimentation tanks. According to the findings, the effectiveness of turbidity removal is dependent on the flow rate, the baffle's placement and height. When the baffles are spaced 14 cm from the bottom of the tank and 6 cm from the entry, effective sedimentation may be achieved. The enhanced tank was able to remove turbidity to a maximum of 99.1% and a minimum of 95.0%. The current study verifies that sedimentation tanks are a viable option for pre-treating very turbid water. This flow rate was deemed appropriate since the sedimentation turbidity was at an acceptable level, which was 8 l/min.

6.0 REFERENCES :

1. Ekama G. A., Barnard J. L., GÄunthert F. W., Krebs P., McCorquodale J. A., Parker D. S. and Wahlberg E. J., (1997). Secondary settling tanks: theory, modelling, design and operation. IAWQ STR No 6, International Association on Water Quality, London.
2. Hinze, J. O. (1975). Turbulence: An introduction to its mechanism and theory. McGraw-Hill Series in Mechanical Engineering, McGraw-Hill, New York. [3] Larsen, P. (1977). ‘‘On the hydraulics of rectangular settling basins.’’ Rep. No. 1001, Dept. of Water Res. Engrg., Lund Institute of Technology, Lund, Sweden.
3. Rodi, W. (1987). ‘‘Examples of calculation for flow and mixing in stratified fluids.’’ J. Geophys. Res., 92(C5), 5305–5328.
4. Rodi, W. (1993). Turbulence models and their application in hydraulics, 3rd Ed., Balkema, Rotterdam, The Netherlands.
5. Taka´cs, I., Patry, G. G., and Nolasco, D. (1991).
6. ‘‘A dynamic model of the clarification-thickening process.’’Water Res., 25(10), 1263–1271.
7. Zhou S. and McCorquodale J.A. (1992). Mathematical modelling of a circular clarifier. Can. J. Civ. Eng., 19, pp. 365-374.
8. Shelestina O., and H. Ratnaweera, Optimization of the sedimentation tank with CFD simulation 2014, https://www.researchgate.net/.
9. Zhang D., Optimize sedimentation tank and lab flocculation unit by CFD, Master Thesis Norwegian University of Life Sciences Ås, Norway February 2014.
10. Hidayah E. N., and O. Hendriyanto, Hydrodynamic model of sedimentation and disinfection to predict water quality in water treatment plant, International Journal of Science, Technology and Society; 2(4), (2014), 73-77 Published online June 20. (http://www.sciencepublishinggroup.com/j /ijsts) doi: 10.11648/j.ijsts.20140204.13
11. Katayon S.C, Megat M. N. and Abdullah A.G.L, “The effectiveness of Moringa Oleifera as primary coagulant in high-rate settling pilot scale water treatment plant” International Journal of Engineering and Technology, 3(2), (2006), 191-200. [12]. Instruction Manual W7, Model Sedimentation Tank. Armfield: Water Treatment Processes, issue 15 March2008.
12. W. L. McCabe, J. C. Smith and P. Harriett, Unit Operation of Chemical Engineering,McGraw Hill publications, 1993.
13. J. Wu and C. He “Experimental and Modeling Investigation of Sewage Solids Sedimentation Based on ParticleSize Distribution and Fractal Dimension,” Int. J. Environ. Sci. Tech., vol. 7, no. 1, pp. 37-46, Winter 2010.
14. M. M. Benjamin and D. F. Lawler, Water Quality Engineering: Physical / Chemical Treatment Processes, Wiley-Blackwell; 1 ed., 2013.
15. J. Oca, I. Masal and L. Reig, “Comparative Analysis of Flow Patterns in Aquaculture Rectangular Tanks with Different Water Inlet Characteristics,” Aquacultural Engineering, vol. 31, pp. 221–236, 2004.

16. O. Levenspiel, The Chemical Reactor Omnibook. OR OSU Book Stores, Corvallis, 1979. [18] B. Firoozabadi and M. A. Ashjari, "Prediction of Hydraulic Efficiency of Primary Rectangular Settling Tanks Using the Non-linear k-ε Turbulence Model," Transaction B: Mechanical Engineering, vol. 17, No. 3, pp. 167-178, 2010.
17. P. K. Swamee, "Design of Flocculating Baffled Channel," J. Env. Engng., vol. 122, no. 11, pp. 1046-1048,1996 .