

A Review on Comparative Design Analysis of Conventional and Lamella Clarifiers For WTP'

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Abstract: - Clarification is an important process in water treatment plants for removing suspended particles from water. Conventional clarifiers generally need a larger settling area, while lamella clarifiers use inclined plates to provide additional settling surfaces in a compact space. This review compares conventional and lamella clarifiers with respect to hydraulic performance, settling efficiency, structural arrangement and material requirements. Previous studies related to clarifier performance, flow behavior, inclined plates and structural analysis of water-retaining structures are reviewed. The reviewed studies indicate that lamella clarifiers offer advantages in space utilization and settling performance, whereas conventional clarifiers have a simpler structural configuration. However, limited research directly compares the structural behavior of both clarifier types under similar conditions. Therefore, parameters such as bending moment, shear force, stress, deflection, reinforcement and material consumption are considered important for further comparison. The review provides a basis for structural modelling and analysis of conventional and lamella clarifiers using STAAD.Pro.

Keywords- Conventional Clarifier, Lamella Clarifier, Water Treatment Plant, Structural Analysis, Hydraulic Performance, Inclined Plates, STAAD.Pro, Reinforced Concrete.

1. INTRODUCTION

Water treatment plants are essential for providing water suitable for domestic and industrial use. Clarification is an important stage of water treatment in which suspended and settleable particles are separated from water before further treatment. Conventional clarifiers generally use gravity settling in a relatively large tank. Although this arrangement is widely used, it may require more space and a larger structural system when higher treatment capacity is required. Lamella clarifiers use a series of inclined plates inside the settling tank to increase the effective settling area. This arrangement allows clarification to be carried out in a more compact space. However, the addition of inclined plates, supports and other internal components also changes the structural arrangement of the clarifier. Therefore, along with treatment and hydraulic performance, the structural behaviour and material requirement of the clarifier are important considerations.

Several researchers have studied conventional and inclined-plate clarifiers in terms of settling efficiency, flow behaviour, hydraulic performance and pollutant removal. Studies related to structural analysis have also used finite element methods and STAAD.Pro for water-retaining structures and clarifiers. However, the available literature provides limited direct comparison of the structural behaviour of conventional and lamella clarifiers under similar design conditions.

The present review summarizes previous studies related to conventional and lamella clarifiers and identifies the major parameters relevant to their comparison. Particular attention is given to structural parameters such as bending moment, shear force, stress, deflection, reinforcement and material consumption. The review also highlights the research gap related to direct structural comparison and provides a basis for further structural analysis of both clarifier configurations using STAAD.Pro.

2. LITERATURE REVIEW

1. **Taebi-Harandy and Schroeder (1995)** studied the **Analysis of structural features on the performance of secondary clarifiers** using a scaled rectangular clarifier model. The study considered inlet configuration, weir location, intermediate baffle and sludge draw-off location as the main structural features. A factorial experimental approach was used to study the individual and combined effects of these features. The results showed that structural arrangements influenced flow patterns, density currents and effluent suspended-solids concentration. The interaction between different structural features also affected the overall clarifier performance. The study concluded that proper selection and arrangement of structural components is important for effective clarifier operation. However, the study mainly focused on

hydraulic and settling performance rather than RCC structural design. The findings are useful for the present study in understanding the effect of structural configuration on clarifier performance and can support the comparative structural analysis of conventional and lamella clarifiers.

2. **Saleh and Hamoda (1999)** studied the **Upgrading of secondary clarifiers using inclined plate settlers** to improve the treatment capacity of conventional settling units. A pilot-scale inclined plate settler was operated using activated-sludge mixed liquor and its performance was compared with a conventional secondary settler. The study considered parameters such as hydraulic retention time, surface loading rate and suspended-solids removal. The results showed that the inclined plate settler performed better, particularly under peak flow conditions, and was less affected by hydraulic overloading. Higher removal efficiency was obtained at increased retention time and lower surface loading rates. The study concluded that inclined plate settlers can be used to upgrade existing secondary clarifiers without major modification. However, the study mainly focused on hydraulic and treatment performance rather than structural analysis. The findings are useful for the present study in understanding the performance advantage and compact arrangement of inclined-plate clarifiers for comparison with conventional clarifiers.
3. **Wood et al. (2004)** studied the **Feasibility of stormwater treatment using conventional and lamellar settling, with and without polymeric flocculant addition**. A pilot-scale rectangular clarifier was used to compare the two settling arrangements under different treatment conditions. The study evaluated suspended-solids and pollutant removal for conventional and lamellar settling. The results showed that the use of inclined plates provided additional settling area and could improve solids removal within a compact arrangement. Polymer addition further enhanced the settling performance of both systems. The study demonstrated the potential of lamellar settling for efficient stormwater treatment compared with conventional settling. However, the study mainly focused on treatment and settling performance rather than structural behavior. The findings are useful for the present study in understanding the performance and compact configuration of lamella clarifiers, which can be considered along with structural requirements in the comparative analysis of conventional and lamella clarifiers.
4. **McCorquodale et al. (2006)** applied a **Computational Fluid Dynamics (CFD) model to improve the performance of rectangular secondary clarifiers**. The

study used a two-dimensional CFD model to analyze flow patterns and suspended-solids distribution within the clarifier. Different structural arrangements, including inlet skirts, extended launders and perforated baffles, were considered. The predicted velocity and solids profiles showed reasonable agreement with measured data. The results indicated that suitable internal structural arrangements could reduce undesirable flow currents and improve clarifier performance. The study demonstrated the importance of inlet and baffle configurations in controlling hydraulic behavior. However, the study mainly focused on hydraulic performance and did not include detailed structural analysis. The findings are useful for the present study in understanding the effect of structural configuration on clarifier performance, which can be considered along with structural parameters while comparing conventional and lamella clarifiers.

5. **Burgos-Flores et al. (2009)** presented a **Mathematical modelling study of lamella plate settler hydraulics** to understand the flow behavior within inclined-plate settling units. The study used tracer experiments and flow visualization to examine the effect of plate arrangement, inlet configuration and outlet conditions. Parameters such as water velocity, residence time and flow distribution were considered. The results showed that the actual flow pattern differed from ideal plug-flow conditions, with regions of short-circuiting and stagnation observed within the settler. The mathematical models provided a reasonable representation of the general flow behavior but could not fully predict these localized effects. The study highlighted the importance of proper hydraulic and plate arrangement in lamella settlers. However, structural aspects of the inclined plates and their supporting system were not considered. The findings are useful for the present study in understanding lamella configuration and flow behavior, which can be considered along with structural analysis while comparing conventional and lamella clarifiers.
6. **Gasperi et al. (2010)** studied the **Occurrence and removal of priority pollutants using lamella clarification and biofiltration in a wastewater treatment plant**. The study examined a wide range of pollutants in raw sewage and evaluated their removal through the treatment process. The performance of lamella clarification was mainly related to the physical and chemical properties of the pollutants, particularly their tendency to attach to suspended solids. The results showed higher removal of hydrophobic pollutants, while hydrophilic pollutants showed comparatively lower removal. The study demonstrated that lamella clarification can contribute to the removal of several priority pollutants from wastewater. However, the study

mainly focused on pollutant removal and treatment performance rather than structural behavior. The findings are useful for the present study in understanding the treatment effectiveness of lamella clarification, which can be considered along with structural parameters while comparing conventional and lamella clarifiers.

7. **Robescu et al. (2010)** presented a study on the **Design of a lamellar secondary settling tank using numerical modelling**. A laboratory-scale rectangular lamellar tank with inclined plates was used to study the flow behavior inside the settling unit. The study combined conventional design calculations with mathematical modelling and numerical simulation to analyze the hydraulic conditions. Different plate arrangements were considered to improve the flow pattern within the tank. The numerical results showed that changes in plate arrangement could reduce undesirable flow patterns and improve the hydraulic behavior of the settler. The study concluded that numerical modelling can be useful for selecting a suitable geometry and arrangement of inclined plates. However, the study mainly focused on hydraulic behavior rather than structural design. The findings are useful for the present study in understanding lamella geometry and plate arrangement, which can be considered while carrying out the structural analysis of conventional and lamella clarifiers.
8. **Lee (2015)** conducted an **Experimental study to evaluate the design procedure of clarifiers with inclined plates and proposed measures to improve their performance**. Laboratory-scale rectangular clarifiers with and without inclined plates were tested under different surface overflow rates and suspended-solids concentrations. The study examined flow distribution through the spaces between the inclined plates and the resulting solids removal. The results showed that simply installing inclined plates did not always improve clarification efficiency. Unequal flow distribution and resuspension of settled solids were identified as important factors affecting performance. The study suggested improving the inlet and outlet arrangement to achieve more uniform flow through the plate channels. The findings highlight the importance of proper inclined-plate arrangement and flow distribution in lamella clarifiers. These results are useful for the present study in considering the structural arrangement of inclined plates while comparing conventional and lamella clarifiers.
9. **Alfanda and Farouk (2017)** presented a **Comparative study of circular and rectangular reinforced concrete tanks from an economical design perspective**. Both tank configurations were designed for the same storage capacity using reinforced concrete and compared based

on material quantities and construction requirements. The study considered concrete, reinforcement steel and formwork as major components of the comparison. The results showed that the tank geometry had a significant influence on the quantity of materials and overall construction cost. The circular configuration provided advantages in some structural and material requirements, while the rectangular configuration offered benefits in formwork and construction aspects. The study highlighted the importance of selecting suitable geometry for achieving economical structural design. Although the study focused on water tanks, the comparison of structural geometry is relevant to the present work. These findings can be used to compare material consumption, reinforcement and structural economy of conventional and lamella clarifiers.

10. **Fouad and Hassan (2018)** compared the **Performance of a sludge blanket clarifier with a conventional settler under high water turbidity conditions**. The study was carried out using field observations and laboratory experiments under varying turbidity and algae concentrations. The performance of both clarifiers was evaluated mainly in terms of turbidity removal, algae removal and sludge accumulation. The results showed that the sludge blanket clarifier provided better turbidity and algae removal than the conventional settler, particularly under high turbidity conditions. It also showed lower sludge accumulation and stable performance during difficult operating conditions. The study concluded that sludge blanket clarification can provide effective treatment with a relatively compact arrangement. However, the study mainly focused on treatment performance and did not consider detailed structural behavior. The findings are useful for the present study for understanding the performance advantages of alternative compact clarification systems, which can support the comparison of conventional and lamella clarifiers.
11. **Srivastava et al. (2020)** presented a **Performance assessment of pulsating floc blanket clarifiers (PFBC) and conventional clariflocculators (CC) using pilot-scale models**. Both systems were operated under similar conditions using alum as a coagulant, and their performance was compared mainly in terms of turbidity and residual aluminum. The results showed that the PFBC provided higher turbidity removal than the conventional clariflocculator, with average removals of about 48% and 23%, respectively. The PFBC also resulted in lower residual aluminum in the treated water. The study indicated that the floc blanket arrangement can provide better clarification performance with a relatively compact configuration. However, the study mainly

focused on treatment performance and did not include detailed structural analysis. The findings are useful for the present study for understanding the performance difference between conventional clarification and compact clarification systems, which can support the comparative analysis of conventional and lamella clarifiers.

12. **Panda and Gupta (2021)** presented a **Primary survey and design of a lamella clarifier-based water treatment plant for Raigarh City**. The study proposed lamella clarifiers as part of the treatment process to provide efficient solids separation within a compact arrangement. The design considered parameters such as flow rate, plate area, retention time, sludge storage and solids removal. The study described the working arrangement of inclined plates, where settled solids slide towards the sludge collection zone and clarified water is collected at the outlet. The results indicated that the proposed lamella system could achieve high solids removal with a relatively compact treatment arrangement. The study highlighted the advantages of lamella clarifiers in terms of space utilization and operation. However, detailed structural analysis of the clarifier components was not presented. The findings are useful for the present study in understanding lamella geometry and design parameters, which can be further used for structural modelling and comparison with conventional clarifiers.
13. **Sameeullah et al. (2022)** presented the **Design of a lamella separator for improving wastewater treatment at NED University**. A lamella clarification unit was incorporated into the existing wastewater treatment system to improve solids removal. The study considered parameters such as plate angle, plate spacing, number of plates and settling area for the design. The lamella separator consisted of inclined plates that provided additional settling surfaces and allowed the settled solids to slide towards the sludge collection zone. The performance was evaluated by comparing wastewater characteristics before and after the installation of the lamella unit. The results showed improved removal of suspended solids along with reduction in BOD and COD. The study demonstrated the effectiveness of lamella systems for compact wastewater treatment. However, the structural design and analysis of the lamella unit were not studied in detail. The findings are useful for the present study in understanding lamella configuration and its structural components for comparative structural analysis with conventional clarifiers.
14. **Naghate and Gupta (2022)** presented the **Analysis of a rectangular water tank using the Finite Element**

Method (FEM). A ground-supported rectangular RCC tank was modelled using STAAD.Pro to study its structural behavior under water pressure. The analysis considered hydrostatic pressure acting on the tank walls and water load on the base. Parameters such as support reactions, displacement and bending moments were evaluated using the finite element model. The study compared FEM results with conventional analytical calculations. The results showed that FEM provided reliable bending-moment values, particularly for rectangular tank configurations. The study demonstrated the suitability of FEM and STAAD.Pro for analyzing water-retaining RCC structures. Although the study focused on water tanks rather than clarifiers, its methodology is useful for the present work for finite element modelling and structural analysis of conventional and lamella clarifiers.

15. **Tayde and Modani (2022)** presented the **Structural analysis of a circular clarifier using STAAD-Pro software**. The study analyzed the structural behavior of the clarifier under different seismic zone conditions. Four models corresponding to seismic Zones II, III, IV and V were considered for the analysis. Parameters such as horizontal displacement, support reaction, shear stress, principal stress, Tresca stress and Von Mises stress were evaluated. The results showed that the structural response increased with the severity of the seismic zone, with higher stresses and reactions observed in the higher seismic zones. The study demonstrated the applicability of STAAD-Pro for analyzing clarifier structures under seismic loading. However, the study was limited to a circular clarifier and did not include a comparison with conventional or lamella configurations. The findings are useful for the present study in considering seismic effects and structural response parameters while comparing different clarifier configurations.
16. **Tayde and Modani (2022)** presented the **Structural analysis of a rectangular clarifier using STAAD-Pro**. The study focused on evaluating the structural behavior of the clarifier under the considered loading conditions. STAAD-Pro was used for structural modelling and analysis, with parameters such as bending moment, stresses and reinforcement considered for design. The study demonstrated the suitability of STAAD-Pro for analyzing and designing rectangular clarifier structures. The results provide a basis for understanding the structural requirements of conventional clarifiers. However, the study was limited to a rectangular clarifier and did not include a comparison with lamella clarifiers. This provides scope for the present study to compare conventional and lamella clarifiers based on their

structural response, reinforcement requirement and structural economy.

17. **Datkar and Pohare (2025)** presented a **Comparative study of circular and rectangular water tanks under different seismic zones using STAAD.Pro**. Eight structural models were analyzed, considering seismic Zones II to V. The study compared parameters such as support reactions, base shear, displacement and overturning effects. The results showed that the structural response of both tank configurations varied with the seismic zone. Rectangular tanks generally showed higher displacement, while circular tanks provided better performance for certain structural parameters. The study highlighted the influence of tank geometry and seismic conditions on structural behavior. However, the study was limited to water tanks and did not consider clarifier structures. The findings are useful for the present study in understanding how structural geometry influences the response of water-retaining structures, which can be applied while comparing conventional and lamella clarifiers.

18. **Sai Shruthi et al. (2026)** presented a **Hydrostatic load response analysis of a rectangular reinforced concrete water tank using STAAD.Pro**. The study considered hydrostatic pressure and other relevant loads acting on the tank structure. A three-dimensional finite element model was prepared to study the structural response under different loading conditions. Parameters such as bending moment, shear force, stress and deflection were evaluated. The results demonstrated the effect of hydrostatic loading on the structural behavior of the tank. The study also showed the usefulness of STAAD.Pro for analyzing water-retaining RCC structures. However, the work was limited to a rectangular water tank and did not consider clarifier structures. The findings are useful for the present study in determining the structural response of water-retaining structures under hydraulic loads, which can be applied while comparing conventional and lamella clarifiers.

19. **Nande and Naktode (2026)** presented the **Structural design and analysis of a circular overhead water tank using the Limit State Method and STAAD.Pro**. The tank components were designed according to the relevant provisions of IS 3370 and IS 456. A three-dimensional STAAD.Pro model was used to analyze the structural behavior under hydrostatic, dead, live, wind and seismic loads. Parameters such as bending moment, shear force, axial force and stress distribution were evaluated. The study compared manual design results with STAAD.Pro analysis to understand the structural response of the tank. The results showed that software-based analysis provides a detailed representation of load transfer and structural

behavior. The study demonstrates the applicability of STAAD.Pro for water-retaining structures. However, it was limited to circular overhead tanks and did not consider clarifiers. The findings are useful for the present study in selecting structural analysis methods and load considerations for comparing conventional and lamella clarifiers.

3. CONCLUSION

The reviewed literature shows that conventional and lamella clarifiers are effective for clarification, but their performance depends on geometry, flow arrangement and internal components. Conventional clarifiers generally require more settling space, while lamella clarifiers provide additional settling surfaces through inclined plates and allow a more compact arrangement. Most previous studies have focused on hydraulic performance, settling efficiency, pollutant removal and flow behavior, with comparatively less focus on detailed structural analysis. Structural studies show that STAAD.Pro and finite element methods can be effectively used for analyzing water-retaining structures and clarifiers. However, direct structural comparison of conventional and lamella clarifiers under similar design conditions is still limited. Important parameters for such comparison include bending moment, shear force, stress, deflection, reinforcement and material consumption. Therefore, further structural analysis can provide a better understanding of the structural requirements and relative economy of both clarifier configurations.

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