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"Analysis of Building with and Without Belt Wall: Water Tank Surrounded By Belt Wall Using ETAB 2016"

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Abstract: In the present situation of a growth of individuals and an emerging demand of an appealing manner of living in a rapidly developing country, the structure sector, particularly structural engineers, is progressively facing new challenges in realizing their dreams. Bracings, outriggers, RC shear wall, shear core, steel shear walls, box frameworks, base isolation, dampers, seismic invisibility cloak, rocking frame, and other advanced innovations have all been established to meet such a demand. One of the solutions we used in research for such problems is the belt wall structure, or the application of this system. With the assistance of an analytical methodology and designing software, this paper summarizes the objective and impact of a structure with outrigger and wall belt supporting systems. The review's main goal is to investigate the impact of a wall belt around a water tank from the perspective of several researchers. The research could also be applied to low-rise structures in seismically prone regions, as well as a comparative analysis with and without a belt wall in tall structures. In the field of research, software evaluation has also been addressed to. This research focuses on a comparative examination of the current research trend on the issue, and comprehensive results are offered following the survey.

Key Word: Belt Wall, Shear Force, Water Pressure, Dead Load, Seismic Load etc.

1. INTRODUCTION

Potable drinking water is commonly stored in water tanks. Due to widespread lack of water, there is a greater increased focus on water storage projects from around entire globe at the moment. Because water is so crucial in daily life, water storing is critical. They kept not just water as well as other liquids, but also goods from large-scale factories. Supportive structures for liquid retention tanks include RC shafts, steel frames, RC braced frames, and even brick work platforms. Tanks are categorized as tank lying on the ground, subterranean water tank, overhead or raised water tank, based on their placement. Water tanks are divided into three types based on their shape: rectangular tanks, circular tanks, and in the tanks. Structures for holding fluids have been redesigned. The limit state design technique was included in the updated version. The structure is planned in a maximum condition of disintegration before being tested for serviceability. The limit state design technique is used in IS 3370:2009. The criteria for restricting fracture width are used in the limit state design process. The main goal of this project is to build water tank using the limit state approach and to evaluate the seismic performance of the water tank while taking into account varying zones and ground conditions [3]. A water tank is used to store water in order to meet day-to-day needs. The impenetrability of cement is typically essential in the building of solid structures for the quantity of water and other substances. Water concrete percentage is mostly responsible for the permeability of any homogeneous and totally compacted cement of certain mix extents. The increase in penetration depth is caused by an increase in the water concrete percentage. Reduced water concrete proportions are appealing because they reduce penetrability, but lowered water concrete proportions, in particular, can produce compaction issues and could be harmful. The design of a fluid-holding construction must be based on the solid avoiding shattering due to its stiffness. Limiting the limits on unrestricted expansion or withdrawal of the construction can also help to reduce the risk of breaking. An RCC Water Tank is being planned, analyzed, and designed [9].

Tall buildings have been a symbol of aspiration and technological growth, resulting in global progression. With the fast growth of urbanization, towering, buildings have become a more practical alternative for business and residential space. Tall structures are typically used for residential, corporate, or commercial purposes. They are essentially a response to the rising urbanization of the population and the need for businesses to be as near as conceivable to one another. In today's towering structures, lateral stresses caused by wind or earthquake forces are frequently resisted using multi systems. The shear walls are connected to the outer columns by an outrigger, which is a stiff beam. When the structure is exposed to lateral forces, the outrigger and columns prevent the core's rotation, reducing the lateral deflection and base moment that would otherwise occur in a free core. Several researches on the analysis and behavior of outrigger constructions have been conducted during the last 3 decades. Belt truss and outrigger systems have recently become popular for reducing lateral drift. Increased bracing sizes, as well as the installation of extra lateral load resisting technologies including such belt truss and outriggers, are necessary to provide the requisite stiffness of tall buildings. The use of outrigger trusses enhances the building's effective depths and enhances lateral stiffness greatly during lateral load [10]. The growing demand for high-quality, architecturally significant buildings and customized roundabouts, as well as the regular growth in height, present new problems and need the development of new protection mechanisms. We must demolish

certain defensive precautions in order to endure earthquakes and strong winds as a result of the building's strength, such as increased instability and high altitude. Bracings, shear walls, outrigger systems, and other examples are only a few. Structure of the Outrigger Belts for outriggers and walls since then, the tournament has continued throughout the country. The reason for this is that when structurally loads are taken into account, with vertical and horizontal supporters in place, a massive quantity of combination loads are created by the structure, which must be supported by the structure itself. Because the ground causes oscillatory, they are related to the structure, and the most effective method to utilize it to withstand the structure is to use these merged systems for stabilizers, straps sustained by the system, and stabilizing system comprising supporting strap.

The bracing method, also known as wall belt or truss belt system, is the most common method employed in high-rise buildings. This system serves as a link between the individuals and the construction's nodes. Belt is commonly made up of trusses or shear walls, joins the outside edge columns of the structure, earning it the name belt supporting system. The load is distributed evenly from each member dispersed to the connecting constructions [1]. Belt trusses, which take the shape of trusses in steel buildings and rigid concrete walls in RC buildings, link all the structure's perimeter columns. Belt truss is not directly interconnected to the shear core (inner lift core), but it transfers forces and moments from the outward column to the shear core via the floor diaphragm. As a result, the floor diaphragm must be rigid enough to transmit forces. In addition to the conventional vertical dead and live load impacts, the floor slabs that carry horizontal stresses from the core to the belt trusses will be exposed to in-plane shear and thus should be proportionate and strengthened suitably. Many purposes may necessitate the usage of slabs that are thicker than usual. Virtual outriggers made of belt trusses provide many of the benefits of outriggers while overcoming most of the drawbacks of traditional outriggers [2].

- The outrigger and core connections are no longer a problem.
- There are no diagonal trusses that run from the centre to the entire building outside.
- Comparative shortness of the core and outer columns would have no impact on the floor diaphragm because they are rigid in their own plane and flexible in the vertical plane.

The belt wall and outrigger provide a variety of tasks, including:

1. All exterior columns assist in preventing the overturning moment.
2. The overturning moments of the structure will be decreased by applying a reversing moment to the building's core wall at each outrigger connection.
3. Structures outside frame can use basic beam and column framing without any need for rigid-frame connections, lowering the overall cost of the construction.
4. Termination or limitation of uplifting pressure and net tension stresses within the structure without the use of a column or foundation systems.
5. There are no trusses in the gap between both the structure's internal core and the outside.

The installation of a wall belt supporting system adds to the Endeavour to create constructions more rigid than previously. The lateral displacement is an important factor that is acquired as little as possible as comparing to when the similar is not used.

Likewise, because concrete is the backbone of the civil engineering business, it plays a significant part in building. The grade's effectiveness will have an impact on the structure's overall functionality. As a result, it should not be overlooked [5].

2. LITERATURE REVIEW

Mohammad Bilal, Sagar Jamle (2020) with the usages of a statistical approach and design software, this study discusses the influence of varying grades of concrete used in buildings where outrigger and wall belt supported systems are employed. In addition, the impacts of earthquake and non-seismic activities on multistory buildings with various concrete grades are briefly explored in relation to outrigger and wall belt support systems in this work. The work's main goal is to investigate the effects of various concrete grades in multistory structures with outrigger and wall belt support systems from the perspective of several researchers. The research may be used to both low and high seismic hazard locations. In the realm of investigation, software evaluation has also been referred to.

Aditya A Chawardol, Dr Bhushan H Shinde (2021) the influence of belt truss and braced belt truss on the vulnerability of structures is demonstrated experimentally. To test this concept, RCC buildings with and without belts truss were studied at various locations. The purpose of this study is to describe and comprehend the many configurations of belt truss structures systems, as well as to integrate existing structures into lengthier structures by employing the belt truss system at various locations. This report also discusses numerous advantages and disadvantages related with outriggers and belt truss systems. The belt truss is discussed in this text at many locations. In which the belt truss structural system is used within the RCC structure to improve the structure's sustainability against earthquake and wind loads.

Tejaswini, Mamatha (2020) Potable water is commonly stored in water tanks. Due to a global shortage of water, a greater emphasis is placed on water storage projects. As a result, water storage is critical since it is essential in regular living. The design for a liquid-retaining structure has been updated in the most recent version. The limit state design technique was included in the updated editions. The building is planned in the limit state of collapse first, and then verified for serviceability. Limit state design is used in IS3370:2009. The extremely high rectangular RC water tank was planned employing the limit state design technique, and observation was performed using ETABS Software for the empty tank, full tank, and full tank condition using linear static evaluation (equivalent static technique) and linear dynamic analysis (response spectrum method).

Yaman Sami Shareef Al-Kamaki, Rondik Adil Jafar (2020) a rectangular reinforced concrete (RC) ground water tank of a full scale is used as a case study in this comparison research in Duhok city. This research involved the construction of identical surface water tanks with a capacity of 9000 cubic meters and a 50 mm junction between them. To guarantee that the tank is crack-free and leak-free, it was carefully examined and designed using the working stress technique. After that, the results were analysed in three dimensions (3D) using ETABS, SAP2000, and SAFE software. Utilizing SAFE software, the tank's mat base and top slab were examined. Bending moments, shear forces, and reinforcement are all calculated in this study.

Durgesh Kumar Upadhyay and Sagar Jamle (2020) Tall buildings are chosen since they use less land for living purposes. This approach was rendered more difficult by seismic activity. The seismic zones where the tremors are noticed are depicted on the I.S. 1893. The shear wall belt system was designed to make the tall structure stiffer and limit its lateral movement. To show this, a total of ten tall buildings are constructed and analyzed using wall belts of various thicknesses and grades. After a thorough investigation, it was discovered that Buildings Case B7 is the best wall belt grading stability case.

Siavash Papi (2020) In ETABS software, a mathematical model of raised RCC and composite water tank was created. The purpose of this article is to investigate the performances of an elevating composite water tank in both full and empty tank scenarios. The corresponding hydrostatic analysis was carried out using the draught code provision of Indian IS 1893 part-II: 2002. In comparison to a raised RCC water tank, the behavior of an elevated composite water tank in terms of base shear and other seismic characteristics.

Navin Kumar, Sambhav Gangwal, Sambhav Gangwal (2021) Buildings with reinforced concrete constructions can successfully bear vertical and horizontal stresses, and shear resistant features, such as stiffening walls and stiffeners, are commonly employed to increase the total height of skyscrapers. It was chosen to explore the variances in the building's elevator from twenty storeys by constructing a complete RCC box at ground level by connecting two neighboring floors to the exterior wall of RCC (belt wall). A central shear core is also supplied for the stabilizers in very tall constructions. The impact of the stabilizer should be carefully investigated for suitably tall buildings without a shear core. As a result, for this study, a structure with a column design and a belt wall system was explored.

Chaitanya Patil, Dr. J.N. Vyas (2021) The article evaluation for this project is based on the Outrigger Wall, Wall Belt, and Outrigger structure. Topic area, so that it is simple to assess the subject knowledge and execution, as well as future-oriented work, is conducted with the aid of reviews. This literature review illuminates the author's attempts to reach a result that promotes constructive behavior for any type of transformation. Various articles were researched and compared the solitary effect of buildings with and without grade change in beam members at various levels against various examples of multistory structures, and all the statistics as well as ratio situations were evaluated, and the results were extraordinary.

Vangaveti Sai Santhosh, Susanta Kumar Sethy, A N Shankar (2020) The seismic behavior of RCC overhead tanks in seismic zone (iii) was investigated using dynamic response spectrum analysis performed utilizing FEM base software (ETABS) in accordance with IS 1893: 2002. Under varied codal provisions, an analysis was performed for an elevation RCC tank in both empty and full tank conditions. Base shear, base moments, and base moments are some of the answers. When the three standards are compared, ACI appears to be the most cost-effective. The codal provisions are categorized as ACI, IS, and BS in terms of economic importance. All 3 codes use the working stress approach, which increases stability.

A.NARENDRA REDDY (2021) this method can be considered as an acceptable structure for high-rise structures, particularly in seismic active zones or wind load dominating areas. With the best location of the outrigger truss put at the top and the 20 level, the storeys structural model exposed to the earthquake load may achieve an 18 percent decrease in maximum displacement. Optimum displacement minimization may be accomplished in a 20-story model by placing the first outrigger at the top and the second outrigger in the midway of the building's height. Three dimensional 40-story models are exposed to earthquake loads, examined, and contrasted to determine the lateral displacement reduction associated to the location of the outrigger and belt systems.

3. FINDINGS

- Study discusses the relevance of various concrete grades in improving the performances of concrete structures. The outrigger and wall belt support structures are producing efficient structures by utilizing technological, according to this study. [1]
- Independently, belt trusses with sturdier floor diaphragms can limit deflection as well as ordinary outriggers, while outriggers with belt truss can avoid maximum deflection better than isolated belt trusses or outriggers. The belt truss technique may be used to support a wide range of composite, steel, and concrete buildings. Belt truss is a low-cost structural element that is quickly becoming one of the most popular structural techniques in modern building. [2]
- In comparison to a full tank, the base shear and base moment for an empty tank are higher. Also, because water tank is emptied, there is no water pressure from within, therefore only seismic forces act from the outside. As a result, in an empty tank, there is increased base shear and base moment. Since lateral forces are greater in full tank circumstances than in empty tank situations, displacement is higher in hard soil in full tank conditions. The crucial reaction of high water tanks does not usually develop under the same circumstances as those described above; it can also largely depend on the earthquake characteristics. [3]
- ETABS, SAP2000, and SAFE applications were used for FEM evaluation and design. Simulated tank walls, slabs, and mat foundations were compared to manual estimations. Author discussed regarding bending moments, shear forces, and steel reinforcing values. [4]

- Determination of the most efficient case amongst general and special cases the mechanism is supported by a wall belt. In Beams and Columns, establish and contrast component Torsion values. [5]
- An examination of the high RCC water tank. Evaluation of a composite raised water tank. For full tank and emptying tank conditions, both water tanks were analyzed using similar static analyses. [6]
- The linear dynamic earthquake load is calculated for a high-rise RCC building with a wall at the outside fringe. The Storey variants of the various instances to be investigated. The alterations in joint displacement that need to be examined. Structure analysis for six different situations, i.e. Belt wall in several locations and bare frame. [7]
- The most often used approach for withstanding lateral stresses is the belt truss and outrigger systems. The most extensive study is centered on the ideal height, shear wall position and height, outrigger depth fluctuations, and so on. The investigators' major goal is to improve the stability of the structure in question; therefore various researchers have seen an increase. Different analyses were utilized to determine the structural form employed by the Outrigger System for High-Rise, Composite Structure, Multi-Outriggers System, Unsymmetrical Tall Buildings, Steel Structure, and Braced Frame System. It prioritizes bracing and outriggers systems, which lessen the influence of lateral stresses. [8]
- To examine the RCC water tank using standard code books from India, the United States, and the United Kingdom. [9]
- The seismic evaluation of three various designs of high rise concrete structures is performed using ETABS software with and without outriggers under moderate soil conditions, and the findings are presented in the following sections. Base shear, torsion, storey drifts, and storeys lateral displacement are the characteristics investigated. [10]

4. STRENGTHS

- The study discusses several analytical approaches for multistory structures that take into account seismic and non-seismic capabilities. [1]
- The review's main goal is to look at the impact of differing concrete grade levels in multistory structures with outrigger and wall belt support structures from the perspective of various scholars. [1]
- Ideal belt truss location for fulfilling deflection requirements, as well as optimal belt truss position for fulfilling deflection and moment criterion. [2]
- For finding usage of belt truss in tall structures, researchers used a variety of methodologies. [2]
- In ETABS, the models are studied utilizing the linear statically and linear dynamic analytics methods. [3]
- ETABS is used to conduct a linearly static examination and a dynamic response spectrum examination for emptiness and full tank conditions using the specifications. [3]
- Three-dimensional (3D) analysis was performed on the results employing ETABS, SAP2000, and SAFE applications. SAFE software was used to examine the tank's mat base and top slab. [4]
- In comparison to manual calculations, design software may be utilized in this manner with a respectable degree of precision. This may keep costs down and prevent human mistakes in any structure, which is a major regional and worldwide concern these days.[4]
- The Response Spectrum Evaluation was carried out on a variety of models, which consists of a G+18 storey semi-commercial building with no shear wall belt. [5]
- The raised composite water tank's essential natural duration has been extended. [6]
- The base shear at the tank's bottoms is approximately 50% less. [6]
- As result, the raised water tank has a superior seismic performance. [6]
- The composite construction can be employed in a water tank that is raised. [6]
- Storey drift falls rapidly from the belt wall's ground level to the neighboring upper and lower stories, but climbs somewhat around the surrounding upper and lower floors. [7]
- For each storey, the floor's displacement on the belt wall diminishes, and then reduces correspondingly. [7]
- The ground floor has a higher bending moment due to the fixed support. [7]
- As the column reaches the neighboring higher and lower planes, the bending moment of the column reduces quickly on belt, but improves somewhat as it reaches the adjacent upper and lower planes. [7]
- From the base to the tip of the floor, the bending moment of the frame structure diminishes equally. [7]
- The three standards are compared; ACI appears to be the most cost-effective. The codal requirements are categorized as ACI, IS, and BS in terms of economic importance. All three codes use the working stress approach, which results in increased stability. [9]
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5. CONCLUDED OBJECTIVES

Main objective is to examine the construction of a structure with or without a belt wall. To investigate the effectiveness of a belt wall in an RC building when subjected to seismic stresses. To find-out the best location for the belt wall to reduce storey displacement. Structure's seismic resilience increased by using just belt trusses and to increase the structure's rigidity. To apply, lateral load stiffening system around a multistory structure, by using a wall belt. Evaluation of a composites raised water tank. For full tank and emptied tank conditions, both water tanks were analyzed using similar static evaluation. To examine the RCC water tank using standard code books from India, the United States, and the United Kingdom.

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