Utilization of Two Different Diaphragms For Analysis of Tall Structure using Analysis Software: A Review

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Abstract- *When a large space within a building needs to be covered without hindrance and supports, architects often deploy waffle slabs to construct floors and ceilings. Structural designers analyse such slabs, assuming the grid work as simply supported system (all four edges) and deriving solutions based on displacement compatibility of beams or plates to arrive at an approximate solution or performing a detailed finite element analysis (FEM) of the slab beam system using any of the generalized finite element software available in the market. This is so because no analytical solution or quick computational tool exists, except for the case of slabs with all edges simply supported. In this study we are performing comparative analysis of ribbed and waffle slab to determine the most stable and distributive one in comparison.*

In this paper we are presenting literature survey related to analysis of high rise building frame considering different types of diaphragm and their arrangements.

Keywords- Bending moment, Deflection, Shear force, Waffle slab, Ribbed slab, review.

I. INTRODUCTION

Majority of the building structures consist of structural elements such as beams, columns, braces,shearwalls,andfloorslabs.Floorslabsinmultistoreybuildings,whichusuallytransmit gravity loads to the structural system, are also required to transfer lateral inertia forces to the structuralsystem.Generally,themodelsusedfortheanalysisofsuchkindofbuildingstructures are prepared without the floor slabs assuming that they have negligible effects on the response ofastructure.Thus,thefloorslabsaresimplyreplacedbyrigidfloordiaphragmsforsimplicity in the analysis procedure. In this case, the flexural stiffness of the floor slabs is ignored in the analysis. In addition, although the beams are located under the floor slabs in a structure, the analytical model were developed assuming that the axes of floor slabs and beams are located on a common plane.

Lot of research has been done by various eminent personalities and researchers across the world on RCC structures. It is observed that the existing design codes & literature have not adequately addressed the problem of effect of floor slabs on buildings. Thus only few research works by eminent personalities have been listed.

II. LITERATURE REVIEW

AtifZakaria et al (2019) this research paper presented assessment on two different slabs namely Grid slab and Ribbed Slab constituting of ribs to evaluate seismic response as they were highly suitable and economical for construction of long span structures. The considered models in this examination were OMRF outline with sheer walls along with the selection of 4,6,8 number of the story by utilizing ETABS programming for investigating and structure, the pursued examination techniques were Equivalent static strategy, reaction range, and time history. The criteria for the analytical comparison were story float, base shear, time-period, story shear and axial force in the columns.

As per the acquired results, the ends were expressed as the suitable determination of the slab framework assumed a significant job in the structure solidness against both sidelong and gravity forces. Grid slab building has a superior seismic reaction than ribbed slab building. At the point when the complete stature of the structure builds the base shear, uprooting, Story shear and float increments at the same time. In OMRF building shear walls takes the tremendous level of the base shear and the storey shear. Around above 95% from the load would-be withstood by shear walls.

Vinit P. Thakor and Tushar N. Patel (2019) the research paper valuated the behavior of reinforced concrete waffle slab attributable to rhythmatic activities of human beings and resonance. The specimen Waffle slab was modelled with the use Element Meshing Method using analytical programming "ETAB's" with various aspect ratios. The analysis included two different dynamic procedures namely, Free Vibration analysis so as to attain natural frequencies and Mode Shapes and force Vibration was use to attain Maximum Displacement.

The results concluded that as soon as the ratio of span increases, the mass raises leading to reduction in fundamental frequency.

Ayad Abdulhameed Sulaibia and Dhifaf Natiq (2017) This research paper introduces the consequences of finite element investigation for two test apparatus (considered from other research works). This examination was based on the utilization of the Finite Element Method (FEM) by utilizing ANSYS (v.15) programming to investigate the rationality of experiments to confirm the legitimacy of FEM by correlation with exploratory outcomes. Besides, some parametric investigations on these works were done to cover the impact of some significant factors on ultimate load capacity and deflection which were not shrouded in the test work. The analytical reports of ANSYS programming for defined models presented great concurrence with the test results. Load-diversion curve for ANSYS models was found higher than the experimental curves. The normal estimation of the relationship factor was (98.85%) for the primary model and (73.7%) for the subsequent one. Results have demonstrated that the level of increment in firmness increments with an increase in the thickness of the slab, however, this expansion was administered by the separating between ribs.

The results stated that the rate of increment in Stiffness expanded with the expansion of slab thickness. Such expansion was monitored by the dispersing between ribs. The two-way ribbed (waffle) slab without a strong part in the area of loading has higher solidness the two-way ribbed (waffle) slab with a strong bit up to a similar farthest point. Past this breaking point, the solidness for this model was marginally diminished.

Mohammed Jasimet. al. (2017) this research paper was subjected to investigation of various stresses non-linear analysis of a one way ribbed reinforced slab of a ten storey structure when addressed to seismic loads The structures are generally designed so as to resist any form of lateral loads (seismic loading) with the use of elastic investigation considering all the about all experience significant inelastic distortions when exposed to intense earthquake tremors.. Current execution based plan methods requirement for conventions to determine the useful execution of structures exposed to such conditions. Encouraged by development in innovation alongside available experimental figures, the nonlinear examination exhibits the techniques for computing basic response outside the versatile range, together with firmness and quality debilitating associated with inelastic conduct of material and immense removals. Thusly, the nonlinear examination was fit for playing a critical situation in the investigation of the plan of present and forthcoming structures. SAP2000 program was utilized to lead the nonlinear direct incorporation examination and estimation of stress and most extreme displacement of the tall structure. The reinforcement of the layered shell component was accepted as a smeared bar. The achieved results indicated that the pressure and displacement for one way ribbed slab was least when contrasted and that strong slabs in tall structures and this diminished beginning to reduce with increment in number of stories likewise, It was even accessed that the most extreme response displacement if there should arise an occurrence of ribbed slab when subject to seismic loading was decreased by 34% in comparison to solid slab and this diminished beginning to reduce with increment in number of stories. Value of stresses in the ribbed slab was quite small at 23%in comparison to stresses seen in the solid slabs.

The results led to the conclusion that one way ribbed slab reduces the stress and maximum displacement in comparison to traditional solid slabs and such reduction decreases simultaneously with increase in number of stories on the structure. Besides, even the value of stress in ribbed slab was less than that of stresses in traditional solid slabs.

K. SAKETH et al (2017) The research paper introduced the data of conduct punching shear in waffle slabs at slab segment joint exposed to concentric punching shear. Even though it was seen that waffle slabs are fundamentally the same as that of flat slabs, the shear load was moderately decreased because a portion of the potential surfaces was lost when it reached out into the waffle section. The current IS code of practice don't consider the punching shear component of waffle slabs. The scientific part was finished utilizing Finite Element programming ANSYS, by applying the concentric load at the piece segment joint on waffle sections, waffle slabs of various sizes and contrasting the investigative results and traditional RC slab. Waffle slabs of various sizes were made by expanding the profundity of the slab by 20%, width of the rib by 25% and one by expanding the strong area. The examination of the test results with the RC slab uncovered that waffle slab invigorated more and when looking at between the waffle slab models of various sizes, giving more profundity in section and thickness of ribs invigorates extra to the structure against punching shear.

The results stated that punching shear strength at the slab segment joint was twice for waffle slab when contrasted against the Normal two-way slab because of the grid design which diminishes deflections of the slab.

JemalBedaneHalkiyo et al (2017) this research paper presented comparative analysis in between solid slab frame and composite slab under seismic loading, besides, gravity

load was analyzed in two procedures, firstly it was valuated manually and lastly with the use of software application STAAD.Pro v8 so as to ensure the stability, ecomic aspects and their capability to resist designed loads as per the assumed life span. Moreover, the structure was demonstrated and dissected utilizing STAAD.prov8i programming and compared regarding plate stresses, redirection and monetary assessment of low ascent Residential structure with a solid slab of rib slab solid square slab utilizing linear static investigation under gravity and horizontal loading.

The results stated that the correlation frame of the private structure built from solid slab required a lesser amount of material (steel and cement) by 5.512% than structure developed from rib slab. The general conduct and story relocation of the strong slab structure has lower in both x-and z-course when contrasted with ribbed section structures. Structures produced using ribbed slab become prevalent and monetary under medium to long-length and lightweight structures. Acquainting voids with the soffit of a slab lessens dead weight and expands the proficiency of the solid area. A marginally more profound area is required however these stiffer floors encourage longer ranges and arrangement of openings. The base bending moment of the strong slab structure has lower an incentive because of horizontal and gravity loads when contrasted similarly as with ribbed slab structures.

Solid slabs edges have the least magnitude of seismic weight, story relocation and storey shear of building. The frame built with solid slab can give adequate limit all through the planned life span of the structure.

Akshay S. Raut and Riyaz Sameer Shah (2016) here the author presented a comparative analysis in between RCC Waffle Slab and Pre-stressed Waffle Slab. At the point when a huge space inside a structure should be secured without block and supports, structural designer frequently conveys waffle slabs to build floor and roof. Waffle slabs are commonly utilized for substantial loads. The analytical work incorporated the investigation and plan of R.C.C. Waffle slabs and Pre-stressed Waffle section for small span, medium span and long-span ranging from 10m to 40m. For investigation reason ETAB 15 (Integrated Analysis, Design and Drafting of Building System) and SAFE 14 (Integrated Design of Slabs, Mat and Footing) programming results were embraced into thought for R.C.C. Waffle section and Pre-stressed waffle piece and manual computation were out for both. Programming in EXCEL was done to acquire the outcomes for different ranges for various components of waffle piece. The integrity of the program was checked by first planning the physically structured slabs comparing the results.

The conclusion stated the depth of all ribs increases with an increase in span length making it an economical option to use a Pre-stressed Waffle Slab. In case of using a Waffle slab for heavy loadings, it was found economical along with other constructional benefits due to its higher stiffness and least deflection. For the bigger range, it has been seen that the utilization of Prestressed was prudent as the depth required when contrasted with RCC for a similar range was quite small thus conservative too.

Sarita R. Khot et al (2016) the research paper presented comparative analysis of Waffle slabs with Flat slabs against the traditional RCC slabs, focusing attention towards its advantages of waffle slabs over Flats slabs and RCC slabs. The comparison was presented with the use of a case study through a design of Waffle Slabs with Flat slabs and RCC slabs as per IS 456-2000 and the comparison was done on various parameters.

The calculus stated that waffle slabs are progressively favourable when contrasted with different sections, for example, flat slabs and RCC slabs, in terms of loading, large spans, aesthetic appearance, etc.

Anurag Sharma and Claudia JeyaPushpa.D (2015) this research paper investigated seismic performance on a multi storey structure of three different tunes such as G+9, G+14 and G+19 floors using Waffle slabs and Flat slabs and the designing and modelling of the structure was done using computer program ETAB'S 2013. The seismic advancement was performed using response range investigation according to IS 1893 (2002). It was seen that waffle slabs were fitting for structure with tallness under 40m, though for structures of stature above 40m it was prudent to go with the flat slab.

The obtained results presented that the maximum displacement estimation of the flat slab was about 16% higher contrasted with a waffle slab in both X and Y directions for G+9 storey building. In G+14 story structure, maximum displacement estimation of waffle slab was 89% higher contrast with the Flat slab in the X direction while in Y direction it increments up to 86%.In G+19 story structure, maximum displacement was consistent in both Flat slab and waffle slab in both X and Y direction with a negligible variation. While concerning G+9 storey building, story float estimation of flat slab shifts from 11% to 14% both in X and Y direction from the waffle slab. In G+14 story assembling, the story drift estimation of waffle slab was 45% to 47% higher contrast with the flat slab both in X and Y direction. In G+19 story structure variation of waffle, the slab was 1% to 3% higher than the flat slab, both in X and Y direction. Results expressed that for structure with tallness under 40m, it was

prudent to utilize waffle slab other than the flat slab, though, for structures of stature above 40m, it was fitting to utilize flat slab.

Ibrahim Mohammad Arman et. al. (2014) This research paper was focused towards analysis of a two way ribbed slab and waffle slabs with hidden beams. Numerous strategies were utilized to dissect two-way slabs and the efficiency of these techniques change contingent upon strategy decision. In this investigation, the ACI direct plan technique was utilized as manual or hand strategy for estimation and the end strategy was contrasted against the examination consequences of the three-dimensional basic models done by the analytical system program SAP2000.

The conclusive results stated, by using Direct design Methodology, the beams can capable enough to resist upto 20% of column strip moment, whereas, slabs are capable enough to resist 80% of column strip moment for slabs with a followed ratio from longer to a shorter span ratio as 1:2. With the use of three dimensional structural model, stated that beams in all the slabs were able to resist 40%-50% of column strip moment whereas the slabs could resist around 50%-60% of column strip moment. This was proven that two-way stripped slabs and waffle slabs along with hidden beams could be customized as the requirement such as slabs without beams called flat plates so as to compute moment to column and middle strips. The greater part of the column strip moments was opposed by the slab, not by the beams. It was suggested utilizing PC programming for investigation of slab frameworks to decide moment in slab strips and beams. There was no basic careful strategy to determine precisely the moments in beams and slab strips in two-way slabs.

NaziyaGhanchi and Chitra V. (2014) the research paper described various approaches those are accessible for the analysis of waffle slab system and their comparison was done on flexural parameters such as bending moment and shear forces. Experimental apparatus included size with contant width 10.00m and varying ratio of hall dimensions (L/B) from 1 to 1.5 was considered in the examination.

The Rankine-grashoff strategy was a surmised method. The Rankine-grashoff strategy doesn't give the estimations of torsion minutes. Rankine-Grashoff strategy belittles basic bowing minute (Mx) and shear power (Qx). Plate hypothesis and Rankine-Grashoff strategy are utilized for basic help conditions. In actuality, the solidness strategy can be utilized for inflexible backings also. In the Plate hypothesis and Rankine-Grashoff technique, bending moment and shear force in Peripheral bars can't be gotten. Truth be told, in solid encircled development, plan minutes and shears in fringe bars will be the most extreme. At first, up to L/B=1.2, Plate hypothesis presented a higher benefit of Bending moment (Mx) for the firmness strategy. With expanding L/B, past L/B=1.3 Plate hypothesis shows a lower benefit of bowing minute (Mx) when contrasted with the solidness strategy. Solidness technique shows the higher estimation of shear power (Qx) when contrasted with different strategies talked about. Plate hypothesis shows fewer estimations of Qx than that of firmness technique. Stiffness strategy is precise and increasingly reasonable to land at structure minutes and shear force. Likewise, Stiffness strategy sets aside less effort for examination.

JieTianet. al. (2012) the research paper presented experimental and numerical analytical results of Multi-Ribbed Slab Structure (MRSS) which is a type of composite structural system composed of prefabricated multi-ribbled composite wall slabs. The results were extracted from four scaled model constituting three one and half scale two storey two Bay models and one third scale three storey two bay models executing pseudo static investigation on all the specimen.
The pseudo-static tests and nonlinear numerical modelling specified that the multi-ribbed slab structure had a decent seismic tremor collapse safe limit. The pseudo-static examination, nonlinear dynamic time - history investigation and push-over examination presented that numerical ascertaining results were in great coincidence with the test results, particularly in the figure of the estimations of the load conveying limit at highlight focuses, which demonstrated that the equivalent strut model and the shear wall model proposed in the paper was practicable.

E. Arellano-Méndez & O.M. González-Cuevas (2012) The research paper presented the study of five full sized Post-tensioned Flat Slab- column connections which were subjected to axial and flexural moment in order to determine their mode of failure, strength and ductility. The factors that were examined were first, the arrangement of stirrups or stud shear reinforcement; furthermore, separating between stirrups or shear studs; and thirdly, connection between the applied axial loads, Vu, and the punching shear quality of the slab with hub load and without shear fortification, VcR. In this examination, waffle pieces were utilized, being more utilized in Mexico than strong chunks for financial reasons. The pliability of the associations was of extraordinary enthusiasm since this sort of structures was generally considered of low or medium malleability because of the punching shear failures was fragile. It has been discovered that the most extreme IDR (between story float proportions) came to in structures with level piece section associations relied upon the connection among Vu and VcR, so this was one of the primary factors in the exploration.

Alaa C. Galeb and Zainab F. Atiyah (2011) This research paper demonstrated the complications associated to optimal design of Two-way ribbed or generally termed as Waffle slabs with the use of genetic algorithms. This research paper included two case studies, one was a waffle slab with solid heads and another was waffle slabs with band beams running along the centerlines. Structural analysis and slab designing was done using Direct Design methodology. The cost capacity constituted the expense of concrete, steel, and formwork for the considered slab. The structure factors were considered as the compelling Depth of the slabs, ribs width, the separation between ribs, the top slab thickness, the flexural reinforcement at the moment critical sections, the band bars width and the territory of steel fortification of the pillars. The limitations incorporated the imperatives on measurements of the rib, and the requirements on the top section thickness, the requirements on the zones of steel support to fulfill the flexural and the base region necessities, the imperatives on the chunk thickness to fulfill flexural conduct, suit fortification and give satisfactory solid spread, and the requirements on the longitudinal support of band shafts. A PC program was composed utilizing MATLAB to play out the basic examination and structure of waffle pieces by the immediate plan technique. The enhancement procedure was done utilizing the implicit hereditary calculation tool kit of MATLAB.

The conclusion derived from the results stated that the expansion in the proportion of concrete cost comparative with the steel cost caused a diminishing in the rib spacing and the cross-sectional territory of the ribs. While the expansion in the steel unit cost comparative with the solid unit cost causes an increment in the cross-sectional zone of the ribs. The expense of formwork of the slab was seen as (85%-137%) of the overall cost of the section for slabs with strong heads and sections with the band beams was (30%-64%). For a similar range length, it was discovered that the absolute expense of waffle section with band pillars along segments centerlines was (10%-112%) higher than the all over cost of waffle piece with strong heads.

RanaShabbar et al. (2010) this research paper aimed to presented the utility of one way ribbed slabs along with light weight foam concrete in reduction of the dead load on concrete slab structures. Its advantage included that architects and engineers shall be able to reduce the size of columns, footing along with other load bearing elements ultimately leading to reduction in construction cost of the structure with efficient space management. Also, the extent of this examination was to plan the one-way ribbed slab and two-way solid slabs with the use of" Esteem®" programming. The analytical system utilized in this investigation comprised of two sections, the initial segment was the Lab tests to measure the density and compressive strength while the subsequent part included the examination of the analytical data extracted by utilizing the ESTEEM® programming. The results of this examination presented that one-way ribbed chunk slab pillar along with a beam in private building is most appropriate option from the economical point of view since it is more affordable than the two-way solid slabs with the shaft. Moreover, the one-way ribbed slab with L.W.F.C. was progressively productive. As an end, it appears that L.W.F.C. could be considered as an option instead of other as often as possible utilized ordinary bond because of its ability to decrease the heaviness of the structure.

The final conclusion states Foam concrete could be intended to meet the criteria of compressive strength of load-bearing cement besides, it's an appropriate arrangement in the development of multi-story structures. Foamed concrete has been distinguished as appropriate material to swap the typical cement utilized for this reason. Simultaneously, the thickness of formed concrete can be structured and controlled by the proportion of the blend and the solidness of the foam utilized. Moreover, the development cost of the one-way ribbed slab with pillars was more practical than that of the two-way solid slabs with bars. Besides, The ESTTEM® programming proved, by all accounts, to be a productive and exact instrument that was dependable to be utilized in the preparation of the examination and calculus.

Indrajit Chowdhury and Jitendra P. Singh (2010) the research paper proposed a semi analytical procedure to analyze the waffle slabs with arbitrary boundary conditions whether they are fixed, or free or just simple supported. The selected cases were compared under Finite Element Method (FEM) so as to validate the results.

The conclusion proposed a computationally efficient method which was comparable to Finite Element Method (FEM) analysis which could be adopted for the analysis of Waffle slabs for generalized boundary conditions. The weighted residual technique proposed in the test examination gave sensible outcomes without turning to an expound FEM investigation.

P. F. SCHWETZ et al (2009) the primary objective of the research work was to analyze the sustainability of various designing procedures most widely used in modelling of all waffle slabs so as to represent the behavior of the slabs. Real scale waffle slab when subjected to load in a confined region was instrumented with strain gages and diversion gages for estimating explicit strain and deflection in various points. The numerical examination was made utilizing a grid model created by local vendors of programming organization spent

significant time in the analysis of the structure. Tests demonstrated a direct conduct, despite the fact that remaining outcomes could show breaking in some disconnected areas. Numerically figured deflections introduced a decent gauge to test results and the exploratory strains characterized the nearness of bending moment incidental with the conjectures of the hypothetical model.

The conclusion derived from the observation stated the measured vertical displacement and found strains were found adequate to numerical predictions, demonstrating a satisfactory reaction of the numerical model utilized in the examination.

III. CONCLUSION

The researchers have tried to find the variation in forces which occurs due to waffle and ribbed slab, following are the outcomes of literature review:

1 Determine that frames with different slab types shows variations as per structural geometry.
2 That structure considering diaphragm is more stable and symmetric.
3 Difference in frame without slab, flat slab and other diaphragm types.

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