Dynamic Explicit of RCC Beam Using ANSYS

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***Abstract*- Concrete structural elements such as beams, columns, walls, slabs, footings exist in various buildings and bridges. It is necessary to understand its behaviour when it is subjected to the different types of loading for an efficient and safe structure. In reality, the most of the problems in the structural elements are nonlinear in nature. In recent finite element analysis method is used to analyse these types of structural elements. This paper discusses about the behaviour of RCC beam when it is subjected to an impact loading. The dimensions of the beam specimen is discussed in the chapter III. The beams are modelled in Explicit dynamic platform of ANSYS. Each beam elements are subjected to velocity of 5 m/s, 8 m/s and 10 m/s. the beam is reinforced with main reinforcement, hanger bars and shear reinforcement. The deformation of the beam specimen with respect to cross section and varying lengths at various velocities are analysed.**

Key points: **ANSYS, Explicit dynamics, Finite element analysis, Nodal velocity, RCC beam.**

I. INTRODUCTION

Concrete elements are existing in the building as different structural parts of it. The bridges dams and other heavy structures re constructed using concrete. The concrete structures are weak in tension and it is good at compression.

In reality, most problems in the structural elements are nonlinear in nature. Therefore, analysis of nonlinear is very efficient platform to get exact solution for the problem. This method which gives the accurate behavior of the structural components or material for estimation of its strength and for recognition of the probability of maximum load carrying capacity of the structural elements. FE method is a mathematical analytical method which sub divides the structural components into many smaller parts. The usage of FEA technology is increased because of immense increment of computer engineering and knowledge. FEA is very suitable for non-linear analysis of the structural components. Each structural elements have different stress and strain behavior.

In this project I have used explicit dynamic platform in ANSYS to find out the deformation of RCC beam. Explicit dynamics methods are a time accumulation method which is utilized to perform dynamic calculations when speed of the loading is important. This platform is used for suddenly changing conditions or interrupted events, such as free falls from the top, higher speed impact loads, velocities and other loads. Ansys is a one of the platforms which is utilized to calculate the flexural behavior of structural element. FE analysis is used for determination of the structural elements which gives exact and quick answers when it is compared to experimental study.

1.1 Objectives

1. To perform dynamic explicit analysis of a RCC beam with varying velocities 5 m/s, 8 m/s, 10 m/s by using ANSYS 23.
2. To find out the deformation of RCC beam when it subjected to different velocities by using ANSYS 23.
3. To understand deformation of RCC beam by changing its cross section and length when it is subjected to different velocities by using ANSYS 23.

II. LITERATURE REVIEW

Emad A. Alwesabi, Alshaikh, et.al (2020), They have studied about Impact resistance of composite. This is an experimental approach of an impact test, that is performed using drop hammer with very low velocity i.e, 2.8 m/s impact velocity to the different type of cement concrete such as PCC, FRC and FRRuC beams. The different ratios of micro steel (MS) fiber vary from 0%, 0.75, 0.825, 0.9 %, 1.0 % and polypropylene (PP) fiber from 0%, 0.1 %, 0.175, 0.25 %, 1% with or without crumb rubber (CR) they are partially replaced with fine aggregate by 20 % of its volume.

M Tajamul Islam, et.al (2019), they studied the behavior of RCC beam by FE analysis using ANSYS workbench software. In this paper they discussed about how RCC beam behaves in explicit dynamics solver in ANSYS. RCC beam of size 1000 x 200 x 110 mm was created in ANSYS and which is tested for impact loading in explicit dynamic platform. An impactor of around 15 m/s and mass of the impactor around 12.519 kg was a stroked to the beam for the duration of $5e^{-3}$ seconds and the changes in the parameter observed from this study are discussed in this journal.

M. C. Yilmaz, et.al (2014), Studied about the Load displacement behavior of cement concrete beam when it is exposed to low velocity impact load. This model was created in explicit dynamics platform of ANSYS software. This paper

discusses about the experiments to understand the effects of loading on the beam specimens when load is applied. They have tested 6 plain concrete beam specimen of size 710 x 150 x 150 mm were tested for the static loading and low velocity impact loading. The loading type and hammer height were chosen as accordingly during the experimental investigation. One of the RCC beam was tested for three-point static loading conditions and the other 5 beams was tested for the drop weight impact test. The weight of impact hammer was around 5.25 kg and made it steel material. Result and discussion of the project is discussed I the end of this paper.

III METHODOLOGY

This research involves FE analysis studies for design parameters of RCC beam in explicit dynamics platform of a FEA software called ANSYS workbench 2023 R2. This paper researches about nine RCC beams of different cross section. These 9 beams are analysed by increasing the velocity at the center of the beam and deformation of the beams are observed. The reinforcement of the beams were same for all the beams. The beams were provided with 3 no's of 20mm diameter main reinforcement, 2 no's of 16mm diameter hanger bars and shear reinforcement of 8mm diameter at 150mm c/c. M35 grade of explicit concrete material is and structural steel is used in this project.

Table – 1 Geometry of the beam specimen

Dimensions in m			***Velocity m/s***		
Breadth	***Depth***	***Length***			
0.2	0.3	1	5	8	10
0.3	0.35	1	5	8	10
0.4	0.4	1	5	8	10
0.2	0.3	3	5	8	10
0.3	0.35	3	5	8	10
0.4	0.4	3	5	8	10
0.2	0.3	5	5	8	10
0.3	0.35	5	5	8	10
0.4	0.4	5	5	8	10

3.1 solution

The solution of this project is to find the deformation of the beam under given velocity. All beam specimens are solved for the total deformation. Run the simulation and monitor the progress of each loading step. Explicit Dynamics simulations use an explicit time-stepping algorithm, and results are typically captured at small time intervals. The below table shows the beam details and its deformation value when it is subjected to different velocities.

Table – 2 Geometry and deformation values for different velocities

Sl no	***Beam dimensions in mm***	***Deformation in mm for different velocities***		
		5000 mm/s	8000 mm/s	10000 mm/s
1	200 x 300 x 1000	3.67	4.11	4.38
2	300 x 350 x 1000	4.25	5.83	6.73
3	400 x 400 x 1000	4.51	7.11	8.10
4	200 x 300 x 3000	4.17	5.09	5.28
5	300 x 350 x 3000	4.68	5.28	6.68
6	400 x 400 x 3000	5.42	7.52	8.65
7	200 x 300 x 5000	4.58	5.72	5.97
8	300 x 350 x 5000	5.73	8.07	9.21
9	400 x 400 x 5000	5.91	8.43	9.87

IV RESULT AND DISCUSSIONS

A Reinforced concrete beam of different cross sections and lengths with varying velocities using the explicit dynamics platform of ANSYS by FEA is performed in ANSYS software. An impactor plate with varying velocities i.e., 5 m/s, 8 m/s, 10 m/s are stroked to the beam at the center of the beam. In this chapter we will discuss about the deformation of the beam with different dimensions by increasing the velocity. The comparison of deformation for different velocities are graphically represented below.

The figure 1 is a graphical representation of Comparison of deformation of 1 m length beam for different velocities. From the study it is observed that increase in the cross section as well increase in the velocities increases the deformation of

the beam. While comparing 8.10mm is the maximum deformation which is occurred in 400 x 400 x 1000 m beam at 10000 mm/s velocity.

The figure 2 represents the comparison of deformation of 3 m length beam for different velocities. From the study it is observed that increase in the cross section as well increase in the velocities increases the deformation of the beam. While comparing 8.66mm is the maximum deformation which is occurred in 400 x 400 x 3000 mm beam at 10000 mm/s velocity.

The figure 3 graphically represents the comparison of deformation of 5 m length beam for different velocities. From this study it is clearly observed that the increase in the cross section as well increase in the velocities increases the deformation of the beam. While comparing 9.87 mm is the maximum deformation which is occurred in 400 x 400 x 5000 mm beam at 10000 mm/s velocity.

Fig.1 Graphical representation of Comparison of deformation of 1000 mm length beam

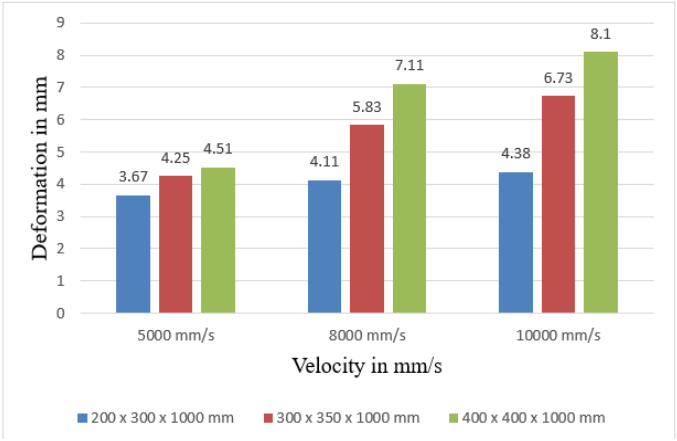


Fig.2 Graphical representations of Comparison of deformation of 3000 mm length beam

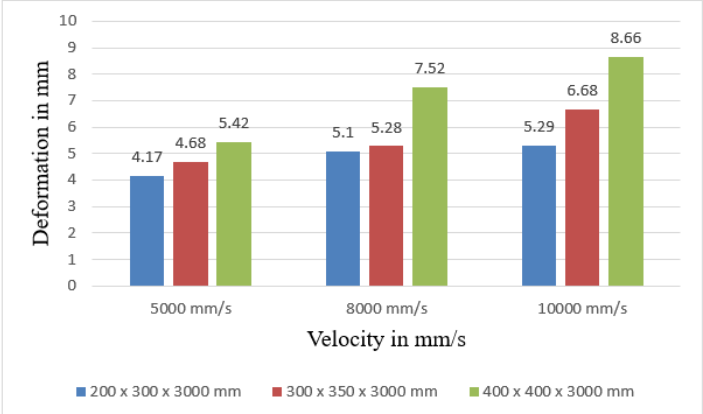
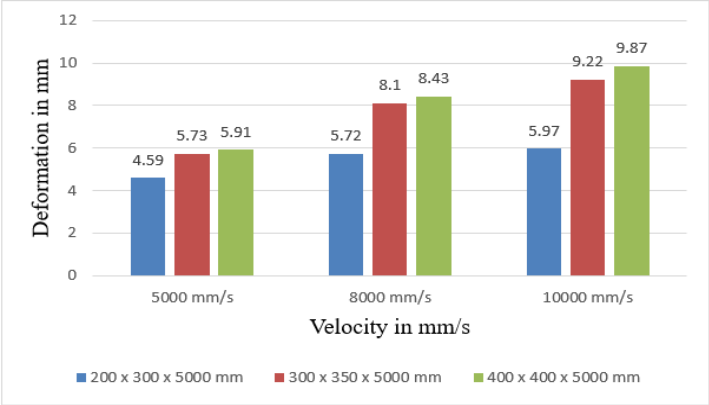


Fig.3 Graphical representations of Comparison of deformation of 5000 mm length beam



V CONCLUSION

In this project, the deformation of RCC beam is analysed using FE method. A RCC beam element of different cross section is analysed by increasing length and the velocities and then then compared the modelled beam by changing its dimensions. The parameters which are opted for the completion of this projects are increasing the lengths and velocities. After completing the analysis, the results from each test, the following are the conclusions that I observed from my study:

- A RCC beam can be modelled and analyzed using ANSYS workbench 2023 R2 software and results can be obtained accurately.
- It can be observed that, when the dimensions of the cross section increase the deformation of the RCC beams also increases
- It is noted that deformation also increases by increasing the length of the beam specimens
- As velocity increases deflection of the beam gets increased.
- The maximum deformation of the beam is 9.87mm is occurred in the 400mm x 400mm x 5000 mm beam when it is undergone 10000 mm/sec velocity at its midspan.
- The maximum deflection of a simply supported beam should not exceed 20 mm, hence in this project the maximum deformation of specimen is 9.87, so the velocities which I applied here is safe.

5.1 Scope of the future study

- In the future study can be done for the different grade of concrete
- The properties of the steel can be changed and analyse it by using ANSYS workbench software
- This study can be done by using different software to compare its accuracy on the results.
- The study can be done by changing its dimensions like cross section, length etc.
- The study can also be done by re-designing for reinforcements.
- Further research can be carried out for the beam specimens with other and boundary conditions and for other members and more complex structures.
- The study can also be done by changing the cover for the reinforcements.

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