









**Figure 9:** Load vs. Deflection Graph upto 220kN

## 7. Evaluation and Discussion

### A. Load deflection relationship

From Fig. 8 the load deflection relationship of control beam and that of replaced beams are found to be similar.

### B. Concrete saving

Concrete is one of the important construction materials. In construction industries large wastage of concrete is taken place. Material cost is a main component in the total cost of the product varying from 25 to 70%. Therefore, in order to control the cost, it is necessary to pay maximum attention for controlling material cost especially through abnormal losses. It should be made sure that the right quantities of materials are consumed with less wastage. This issue can be minimized by avoiding concrete in the neutral axis without bearing significant strength. Saving of concrete can be efficiently achieved with increase in length and depth of the beam. Therefore it can be effectively utilised during the construction of plinth beams, raft foundation, piers and similar other works.

Total volume of the beam = 60000cu.cm

Volume of concrete below neutral axis in zone 1 and zone 2 = 20000cu.cm

In case of 4% replaced beam, 50nos. of 3.5cm diameter polythene balls are used.

Volume of 50 polythene balls = 1122.46cu.cm

Reduction in volume below neutral axis in zone and zone 2 = 18877.5 cu.cm.

% reduction in volume in zone 1 and zone 2 = 5.613%.

It is more advantageous for large construction where wastage is more.

### C. Ultimate load carrying capacity

The ultimate load carrying capacity of control beam is comparable to that of replaced beam with 4% and 8% voids.

### D. Labour reduction

Labours are one of the major resources in construction industries. Direct labour cost is also a part of the prime cost. It is clearly evident from the study that the total volume saving in concrete is directly proportional to the percentage reduction in labour. Concreting works in construction industry is labour intensive. When the volume of concreting works reduces, the need for labour also get decreased simultaneously, which in turn minimise the production cost.

### E. Cost reduction

In current days of competition, it is necessary that a business concern should have utmost efficiency and minimum possible wastages and losses to reduce the cost of production. If the cost of inputs increases, then naturally, the cost of the production will go up. The inputs in construction fields include material, machines, labour and other overhead expenses. From the above conducted pilot study it can be concluded that by using partial replacement of reinforced beam below neutral axis will bring significant reduction in the amount of concrete without bearing the strength upto a certain limit. This saving in material cost is more effectively utilised when considering large depth and length of beam or in similar other works, where abnormal loss of concrete occurs. This can be compared to a chain reaction because as the volume of concrete decreases, the material cost reduces which decreases the labour cost, which in turn minimise the construction cost.

### F. Application

From the evaluation of the results, it is observed that the areas of application of the experimental reinforced beam with region below the neutral axis is replaced with voids include in various fields of construction where abnormal losses in concrete occurs. The wastage of concrete can be minimized by adopting this technique of hollow neutral axis of low stress zone without suffering much strength. The fields of application are:

- RC beam.
- Raft foundation.
- Slabs.
- Similar works.

## 8. Conclusion

Behaviour of reinforced concrete beams with region below the neutral axis with voids created using polythene balls is similar to that of conventional reinforced concrete beams. Presence of voids instead of concrete in the low stressed zone has not caused significant reduction in strength of reinforced concrete beams. It has been observed that the replacement of concrete by voids in reinforced concrete beams does not require any extra labour or time. Economy and reduction of weight in beams depends on the percentage replacement of concrete. The concrete saving will be more effective as the length and depth of the beam increases. Replaced reinforced concrete beams can be used for sustainable and environment friendly construction work as it saves concrete which reduces the emission of carbon dioxide during the production of cement. This work can be further elevated by doing experiment with various percentage of replacement and by introducing other weightless inert materials which can take up stress.

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## References

- [1] Jain Joy and Rajesh Rajeev (2014)—Effect of Reinforced Concrete Beam with Hollow Neutral Axis, *International Journal For Scientific Research And Development* (2014), volume 3, November.
- [2] K.K. Pathak, Rakesh Patel And S.K. Dubey (2014), —Analysis Of Infilled Beams Using Method Of Initial Functions And Comparison With FEMl, *Engineering Science And Technology, An International Journal* (2014) 1e7, May
- [3] B S Karthik, Dr.H.Eramma & Madhukaran (2014), —Behaviour Of Concrete Grade Variation In Tension And Compression Zones Of RCC Beamsl,*International Journal Of Advanced Technology In Engineering And Science*, Volume No.02, Issue No. 07, ISSN 2348 – 7550 July.
- [4] Dr. G. Hemalatha And W.Godwin Jesudhason (2013), —Experimental Investigation On Beams Partial Replacement Below The Neutral Axisl, *International Journal Of Civil And Structural Engineering Research*, Vol. 2, January.
- [5] A.Paul Makesh, S.Moses Aranganathan, S.Seileysh Sivaraja (2011), —Cost Effectiveness To Residential Building Using Green Building Approachl *International Journal Of Engineering Science And Technology*, Vol. 3, No. 12, ISSN 0975-5462, December.