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BEHAVIOUR OF INFILLED VIERENDEEL GIRDER WITH OPENINGS UNDER STATIC CYCLIC LOADING

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Abstract - *This paper deals with an investigation carried out by the authors to study the behavior of reinforced concrete infilled Vierendeel girder with openings under static cyclic loading. Details of tests carried out along with observations made are fully described. Since it is a statically indeterminent structure shear, bending and axial capacity of these members contribute to the resistance to the external loads. A simple method is suggested for predicting the exact mode of failure and the ultimate load.*

Key Words: Vierendeel girder, Infill with openings, Cyclic loading, Ultimate load, Effective stiffness.

1.INTRODUCTION

Reinforced concrete Vierendeel girders have found interesting applications in the construction of buildings and bridges. The analysis and design of the girders is mostly by elastic theory which assumes that the material is homogeneous, isotropic and has linear stress-strain relationship. It is well known that the actual behaviour of reinforced concrete structures is very different from that of such idealised materials. The authors have tested these girders to destruction, the load – response characteristics, not only in initial stage of cracking but also in the ultimate load conditions could be studied. As a result a method is suggested to exact mode as well as ultimate load of failure of reinforced concrete vierendeel girders. The investigation provides in addition useful information on stiffness and energy absorption.

1.1 DETAILS OF GIRDERS

There were five different type of girder were tested. For convienience in test arrangements, the same span 1275×700mm^2 was adopted for all girders, but four girders were infilled by bricks and has openings at center, at off load diagonal, on load diagonal and other girder was bare. The horizontal members in all girders had a cross section 100×100mm^2, while all the vertical members were 100×75mm^2.

1.2 FABRICATION OF TEST GIRDERS

In general all the horizontal and vertical members were reinforced uniformly with 4 Nos of 6mm dia. The members were all closed rectangular stirrups of 3mm dia.

Ordinary Portland cement, locally available river sand and granite coarse aggregate of maximum size 12.5mm were used for concrete. A mix proportion of 1:2:3 by weight of water cement ratio of 0.5 was used.

All the specimens were cast in the horizontal position in a suitable mould. Concrete was poured in three different layers and compacted by vibrator and cured in water tank for 28 days.

The girder was infilled by the bricks size 90×90×9mm also openings were made and cured for 28 days by gunny bags before testing.

The girders were white washed in order to study crack behaviour clearly.

1.3 ARRANGEMENT OF GIRDER

The Vierendeel girder were tested in the loading frame as shown in the figure. The girder was simply supported on the longitudinal joist of the frame. The single point load is directly applied through hydraulic jack. Deflection was measured using digital dial gauge kept at a distance of L/2.

2. PRESENTATION OF TEST RESULTS AND DISCUSSION

Typical load–deflection graphs were constructed for all girders. The deflection were maximum occurring load and measured almost till failure. It may be seen that the relationship is not completely linear, as may be expected in reinforced concrete structures. Linearity, if any, is very short

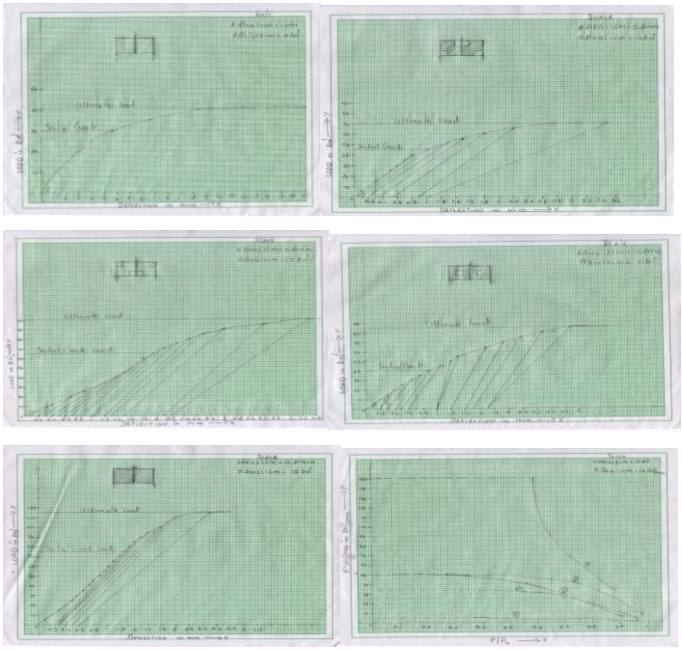
lived and is confined to the earliest portion of load response characteristics. As the load becomes higher, the elasto-plastic behaviour is increasingly apparent. Towards the last stages of loading, the graphs become almost horizontal. The nature of load-deflection relationship thus admits an idealisation of an elastic and then a perfectly plastic behaviour of the girders. Further, these graphs gives the comparative idea of the stiffness and energy absorption of different type of girders.

Table -1: Results

FRAMES	ULTIMATE LOAD (kN)	MAX DEFLECTION (mm)	ENERGY ABSORBTION (kN mm)
BARE FRAME	41	21.8	445
ON LOAD DIAGONAL	70	3.4	170
OFF LOAD DIAGONAL	100	4.4	240
OPENINGS AT CENTER	85	2.9	144
FULLY INFILLED	115	2.5	155

Maximum ultimate load taken is 115kN by fully infilled girder and it shows a greatest result in test. The second maximum ultimate load taken is 100kN by off load diagonal girder. like wise the maximum stiffness is taken by fully infilled girder and second maximum is taken by off load diagonal.

Chart: Load deflection and Stiffness



Maximum energy is absorped by bare girder of 445 kN-mm and also the maximum deflection is taken by the same bare frame of 21.8mm

3. CONCLUSIONS

The fully infilled Vierendeel girder shows better results than other girders. But the girder with opening at compression side is more efficient than the girder with opening in tension side. The infill girder with center openings was less efficient than other infilled girders whereas girder without infill gives perform lower compare to the other girders

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