Comparative Study of Force Development Under Seismic Loading on Monolithic Joint and Dry Precast Joint

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***Abstract*: Two types of joints in total were used, and the axial stress on the column was maintained while they had the same reinforcement ratios, specimen dimensions, and details. These values were obtained from an experimental study done previously by IIT Kharagpur, in which they were compared just for static incremental loading. It was then recommended that the seismic loading may also be compared. Then, using ABAQUS and specifications from the prior work, detailed non-linear finite element (FE) models were created. It is demonstrated that, like earlier experimental studies, FE models can accurately validate the overall performance of both joints in terms of displacement with respect to load. The introduction of the Load Controlled and Displacement Controlled loading condition enables the seismic performance of the proposed joint to be determined. Results of the running explicit analysis are obtained.**

***Index Terms:* Dry Precast Joint, Energy Dissipation, Degradation.**

I. INTRODUCTION

There is a lot of pressure on the construction sector to complete projects more quickly as a result of the rapid expansion of urbanization. In this case, pre-cast construction technology becomes the best choice. Precast components allow for the advancement and streamlining of construction procedures as well as the simpler adoption of new technological methods. Since prefabrication is linked to quality improvement while material needs, labor hours, and costs are typically on the reduction, it is becoming more and more crucial in the competition between precast and monolithic structures.

To increase seismic performance, the wet manufactured precast connection, also known as a hybrid connection, is widely employed. The truth is, however, that employing this form of connection when producing precast members leads to extended assembly periods, a larger workforce, sporadic business closures, and eventually higher costs. When a structure is required in low-temperature areas or circumstances where it will only be needed for a limited period of time, this kind of wet connection and formal monolithic construction has become unworkable for developing countries with weak economies like India.

This study was prompted by the fact that precast construction is one of the least understood aspects of architecture and largely focused on the seismic performance of precast member assembly. Wherein the dry joint is largely taken into account as a component of inexpensive housing to facilitate quick installation. The notion that hogging moments from gravity loads are more significant than sagging moments from lateral loads is used to test the beam-column junction under seismic loading.

In order to provide homes for remote locations and to implement certain government housing programs cost-effectively, this study lays a higher emphasis on cost savings. For a comparative investigation of behavior under static loads, IIT Kharagpur has chosen previously developed monolithic and dry precast joints with identical specifications. In this chapter, the proper basis research is first investigated, and all the key aspects of joints—such as RCC design, loading patterns, and boundary conditions—are taken into consideration. The same specification that is described in detail in system development of System Development is then used for ABAQUS modeling.

Similar to seismic loading conditions, static loading conditions are derived based on basic research, as discussed in system development. First, static loading is applied to the modal in ABAQUS, and the findings are evaluated using data from experiments. The identical ABAQUS modal is then subjected to seismic loading, and results are produced. As a result, the behavior of a certain kind of dry precast joint is examined and contrasted with that of a monolithic joint system.

II. SYSTEM DEVELOPMENT

Exact non-linear finite element (FE) models were created in ABAQUS finite element analysis software utilizing the "explicit dynamic" analysis approach, which is appropriate for complex contact situations like those in precast connections, in order to conduct analytical tests. The models were exposed to a constant axial force and a top displacement that increased monotonically. The created models are described in depth in the parts that follow, along with a comparison of the projected responses' accuracy to the outcomes of experimental tests. [1].

The beam-column junction was created in ABAQUS using 3D deformable element of type C38DR.

- Property

Concrete:
Grade- M30 Mass density- 2400 Kg/m3
Young's Modulus- 25.72 GPa
Poisson's Ratio- 0.20
Dilation angle- 36
Viscosity parameter- 1E-7
Steel:
Reinforcing bar- FE415
Angle section- FE250
Mass density- 7850 Kg/m3
Young's Modulus- 210 GPa

Poisson's Ratio- 0.30

- The interface contact between the reinforcement and concrete is modeled as embedded region.
- General contact definition is used in this model.
- The incremental loading is applied on the end of the beam.
- Finally, the results are obtained.

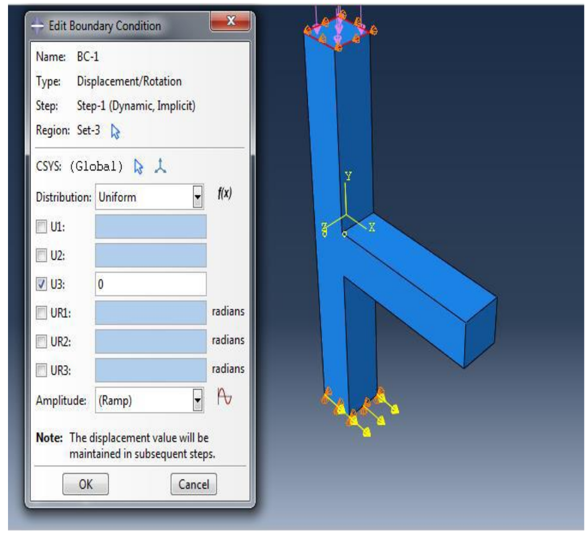

Figure 1: Monolithic Specimen

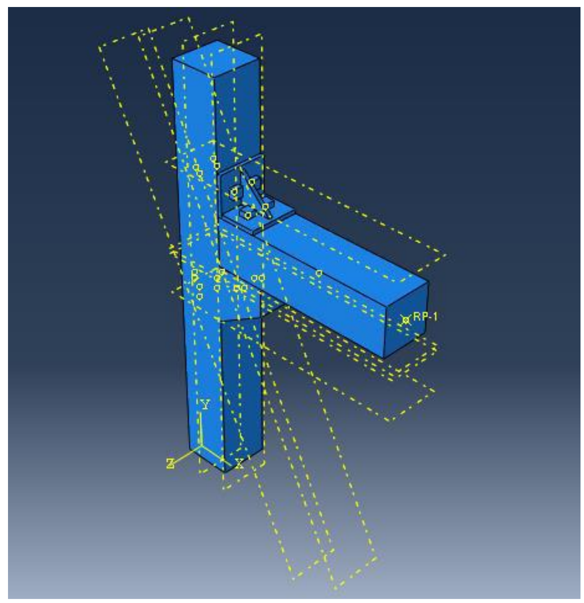

Figure 2: Dry Precast Specimen

III. LOADING CALCULATION

You must apply seismic loads to any model before doing seismic analysis on it. However, it is not possible to directly apply genuine seismic loads to any structural component. So that seismic state manifests on the model, reverse cyclic loading is applied. Reverse cyclic loading has been employed in all prior studies to analyze seismic performance. There are two steps to this reverse cyclic loading that you must complete. The first is the load control stage, when a certain load is delivered for a predetermined amount of time. Three cycles of three different loads, each lasting eight seconds, start at zero and conclude at zero in the displacement-controlled stage. In a displacement-controlled stage, a group of three cycles with identical amplitudes is applied, with each cycle lasting eight seconds and beginning and ending at zero. The load cycles in the load-controlled stage shift from 0.25p, 0.5p, and 0.75p where p=10000N. Each cycle's displacement in a displacement-controlled stage changes as, 2, and = 0.002m. Tables 1 and 2 list the calculated loading conditions. Figures 3 and 4 illustrate this in a pictorial manner.

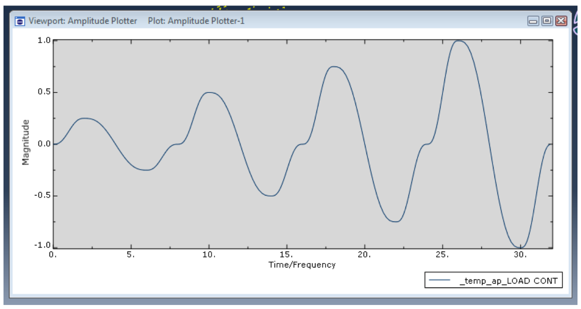

Figure 3: Load Controlled

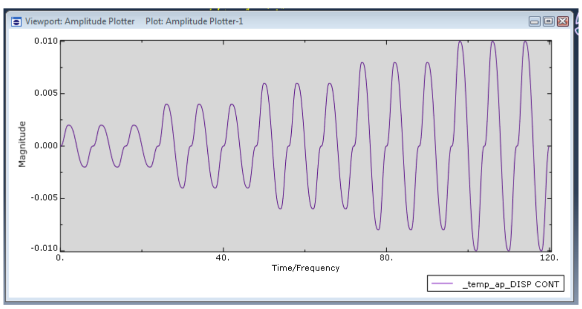

Figure 4: Displacement Controlled

Table 1: Load Controlled

Time	Load Controlled
0	0
2	2500
6	-2500
8	0
10	5000
14	-5000
16	0
18	7500
22	-7500
24	0
26	10000
30	-10000
32	0

Table 2: Displacement Controlled

Time	Displacement Controlled
0	0
2	0.002
6	-0.002
8	0
10	0.002
14	-0.002
16	0
18	0.002
22	-0.002
24	0
26	0.004
30	-0.004
32	0
34	0.004
38	-0.004
40	0
42	0.004
46	-0.004
48	0
50	0.006
54	-0.006
56	0
58	0.006
62	-0.006
64	0
66	0.006
70	-0.006
72	0
74	0.008
78	-0.008
80	0
82	0.008
86	-0.008
88	0
90	0.008
94	-0.008
96	0
98	0.01
102	-0.01
104	0
106	0.01
110	-0.01
112	0
114	0.01
118	-0.01
120	0

IV. RESULTS

4.1 Monolithic Specimen:

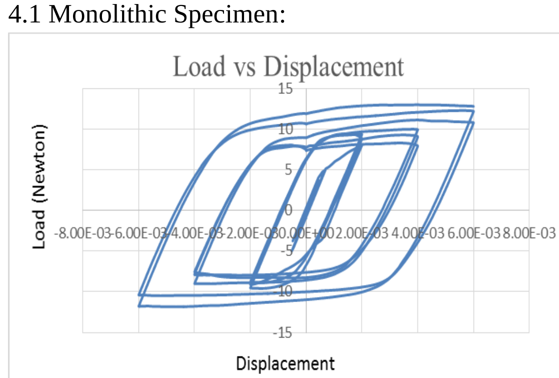

Figure 5: Hysteresis Curve

It is shown in above figure 5 and 6 the downward load is defined as positive load and upward load is defined as negative load. The beam is designed as per IS 456:2000. The hysteresis curve for monolithic joint increases nearly linear before yielding and the area of hysteresis loop is smaller and for load-controlled cycle i.e., pinching effect. After yielding hysteresis curve goes straight with very less change in reaction force as compared to change drift ratio. For same displacement in each cycle there is significant increase in reaction force which shows increasing bearing capacity. In static loading displacement at ultimate at ultimate point is 15.12mm at a load of 15KN but in dynamic loading displacement at ultimate point is 6mm at a load of 12.9KN. Which is decrease by 36.96% in displacement and 14% decrease in load carrying capacity. By above analysis we can say that at lower displacement the joint will achieve ultimate point and early failure.

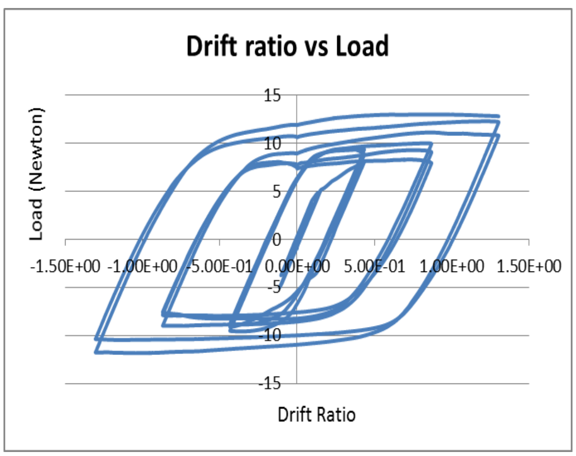

Figure 6: Drift Ratio

4.1 Dry Precast Specimen:

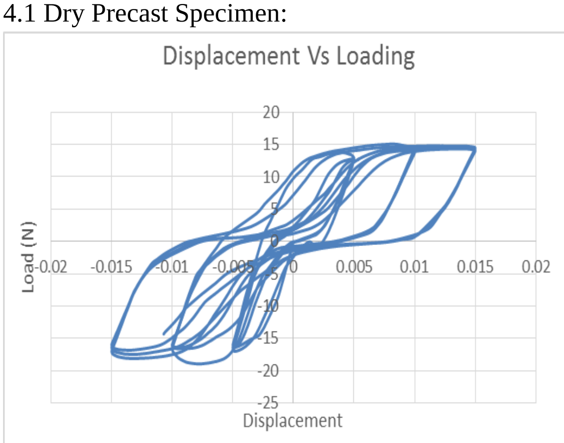

Figure 7: Hysteresis Curve

The hysteresis curve for dry precast joint increases linearly as shown in figure 7 and 8 before yielding and area of hysteresis loop is large and for load controlling cycle there is no yielding effect. Due to which we will get more reaction force at lower displacement. After yielding hysteresis curve goes straight with less change in reaction force as compare to change in drift ratio. For same displacement in each cycle there is no proper increase in bearing capacity. In static loading displacement at ultimate point is 17.03mm at a load of 17KN. But in dynamic loading displacement at ultimate point is 15.04mm at a load of14.03KN. Which is decrease by 11.68% in displacement and 17.47%. By above analysis we can say that at lower displacement the joint will achieve ultimate point and early failure.

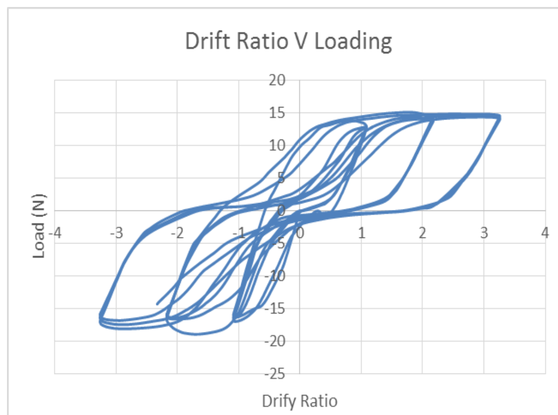

Figure 8: Drift Ratio

V. CONCLUSION

1] A suitable dry joint precast beam column joint is suggested to address the issue of poor construction condition, low construction efficiency and difficulty in accounting for ecological protection in urban development in areas with an extremely cold climate and high seismic intensity. One monolithic and one dry precast joint is modeled in ABACUS and reverse cyclic loading is applied and both the connections are analyzed.

2] Reaction force developed in dry precast joint is more than monolithic connection at yield point and ultimate point.

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