Study on joints in pre-fabricated wall panels

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Abstract

This Project deals with the study and analysis of precast wall panel connections. The integrity of a precast system depends on connections more than the structural members itself. The connections between panels are the key factors which affects both the speed of erection and the overall integrity of the structure. The types of connection proposed in this study are dry pack plain surface connection and multiple shear keys connection. The shear keys are used to increase the shear carrying capacity of the connections. The connection between the walls is called loop bars connection. Between the looping bars, one transverse bar is inserted as to ensure connectivity of all the looping bars. This connection produces a gap between the walls, which would then be filled with grouting material. The main objective of this study is to determine behaviour of connections under shear loading.

Keywords: ***Wall panel connections,vertical connection,grouting, shear loading.***

I. INTRODUCTION:

Prefabricated concrete shear wall panels are used extensively in high rise construction. Precast concrete structural systems benefit from advantages, such as improved quality of construction, efficient use of materials, reduced construction time, and cost efficiency. In addition, precast concrete allows architects and engineers to perform more innovative designs than traditional casting-place concrete design. One of the main concerns in precast concrete construction is the method by which the panels are connected. Connections must provide adequate strength, ductility and continuity in order to insure the integrity of the structure under various loading conditions. It is most important for a successful construction of precast reinforced concrete structures in terms of the structural behaviour.

The main purpose of the structural connection is to transfer forces between the precast concrete elements through connections in order to obtain structural interaction once the system is loaded. The connections between panels are extremely important, since they affect both the speed of erection and the overall integrity of the structure. Therefore, the structural connections should design properly as the same for the precast. The design of connections is one of the most important considerations in the structural design of a precast concrete structure. The purpose of a connection is to transfer load, restrain movement, and provide stability. Within any one connection, there may be several load transfers; each one must be designed for adequate strength and ductility and be appropriately detailed

A. *Connection types*

1. Plain surface connection

2. Multiple shear-key connection(23&45degree)

1. Plain surface connection

Connection DP had a plain surface region filled with dry pack. This specimen was used to identify the contribution of the dry pack to the connection behaviour and is the control specimen for the study. Typically, some form of vertical continuity element is required across the connection.

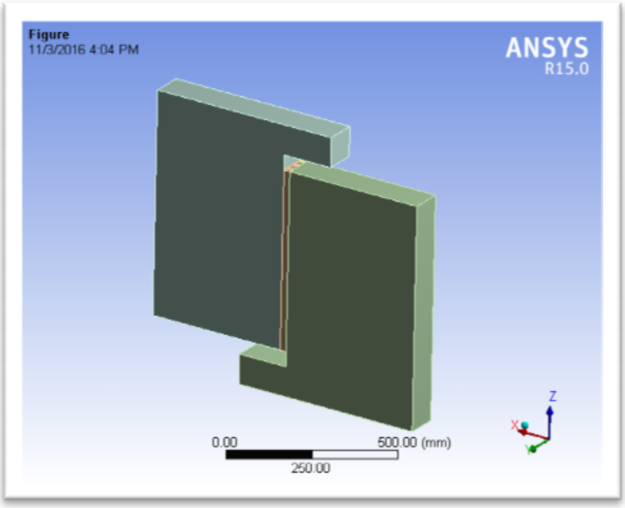

Fig.1 Plain Surface Connection

2. Multiple shear-key connection

The connection interface surface for Connection SK consists of five shear keys. The length of the shear key is 100mm (4in.), the depth is 35mm(l/8in.) and the sides of the key are inclined at 23degrees from the vertical. The shear keys and the gap between the panels are completely filled with dry pack grout. No vertical reinforcement is provided across the connection interface in order to study the influence of the shear keys alone. Two types of angles are used in the shear key which are 23 and 45 degree, in order to find the efficient shape of shear key which can take maximum shear loads.

As a result of the interlocking action of the drypack shear keys, the maximum shear capacity of the multiple shear key connections was approximately 60 percent higher than that of the plain surface connection. The connection interface surface for Connection SK consists of five shearkeys.Theshearkeys and the gap between the panels are completely filled with drypackgrout.No vertical reinforcement is provided across the connection interface inorder to study the influence of the shearkeys alone. Two types of shear keys are used in common (i.e)small shear key and large shear key

The Ultimate shear resistance of the multiple shear key connection was as much as 25 percent higher than that of the plain surface connection. The smaller increase in ultimate shear resistance, in comparison to the maximum load, is probably due to the presence of extensive diagonal cracks in the drypack shearkeys.The vertical joints are designed to transfer shear forces under lateral loads. The joint faces are indented to provide shear keys for shear transfer with increasing lateral loads. Beyond cracking of concrete, a strut-and-tie action is expected to develop.

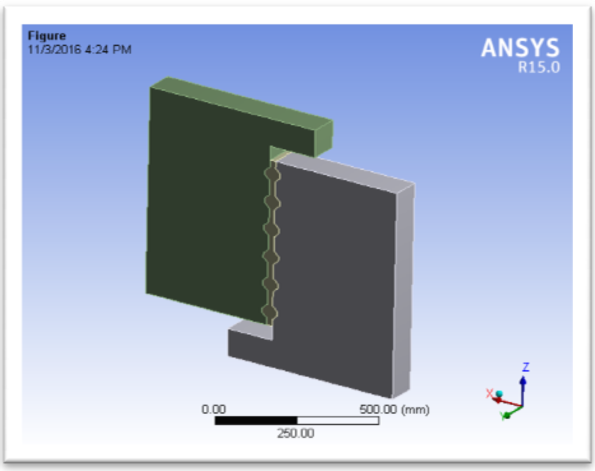

Fig. 2 Multiple shear-key connection

II. LITERATURE REVIEW

Based on various literatures, it is that connections in precast wall panels, including shear walls, must be designed to transfer all design forces and moments. The presence of shear keys in the horizontal connection enhances the shear capacity in comparison to the plain surface connection. The difference in the shear key configuration had an insignificant effect on the behaviour capacity of connection.

Table. 1 Mix proportion

Cement	Fine Aggregate	Coarse Aggregate
465 kg/m^3	771.27 kg/m^3	983.86 kg/m^3
1	1.65	2.11

Mix Design for M40 Control Concrete = 1 : 1.65 : 2.11

III. ANALYTICAL STUDY

The analytical study is done using the software called ANSYS.Using ANSYS we find the maximum shear stress and the equivalent stress the connections can take .

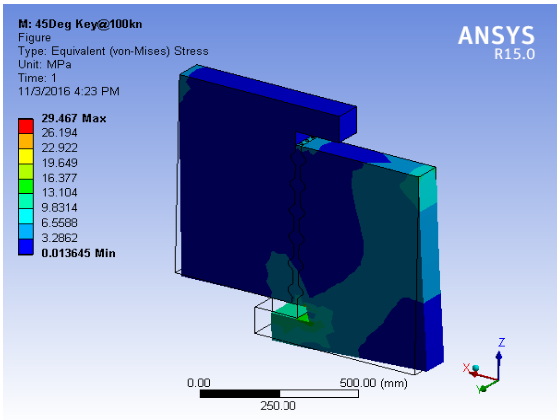

Fig. 3 Equivalent stress in multiple shear-key connection

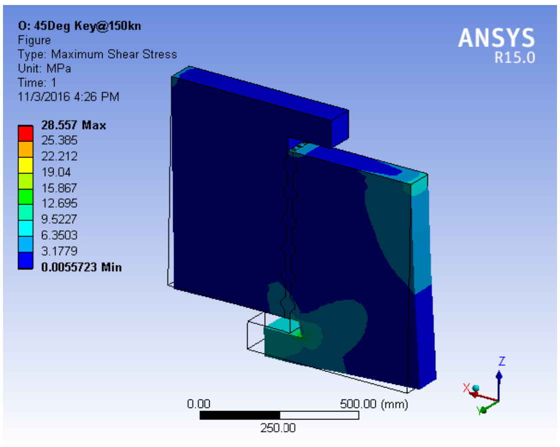

Fig. 4 Maximum shear stress in multiple shear-key connection

IV. EXPERIMENTAL STUDY

The experimental study comprises of casting,curing and testing of wall panels. The connection type comprises of multiple shear key connection which is of 23 and 45 degree.The specimen will be tested under the cyclic loading ,both the vertical and lateral loads will be applied on the wall panels.

V. DIMENSIONS OF WALL PANELS AND CONNECTION

The wall Panels dimensions are assumed as 1.5m height, 0.75m width and 0.1m thickness.The loop bar is provided with a diameter of 12 mm is used to connect the two panels. The length of the bar is provided as development length which is 50 times the diameter. The transverse reinforcement bars of same diameter are provided between the loops. Shear keys of different shapes are provided to study the behaviour of connection.

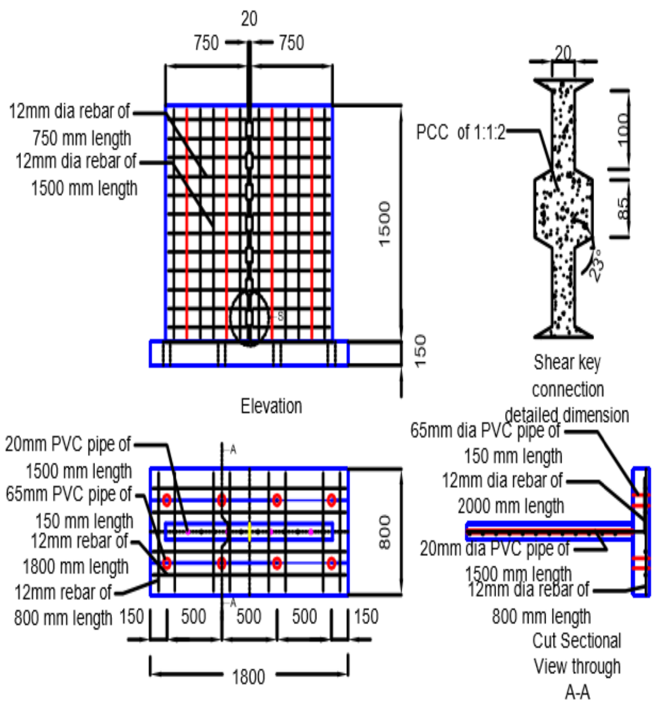

Fig. 8: Detailing of wall panel connection

The gap between the panels are filled with dry-pack grout which is comprises one part of cement two parts of sand and 0.8 parts of water. The wall panels are placed in the slab. The dimensions of slab are 0.8m breadth and0.15m thickness.

Fig 9 : Casting of wall panel and slab

Fig 10: Erectedwall panels

The wall panels are erected in the slab by providing the 20mm PVC pipe while casting itself. With the help of vertical reinforcement from the slab erection process will be done.After erection grouting in the connections should takes place.The 12m dia bar of 0.75m is used in wall panels and 12mm dia of 0.8m is used in the slab. Two vertical reinforcements of 12mm dia and 1.5m length are provided to erect the wall panel in the slab. Slab is used to avoid the wall panels from slip during the testing.

VI. RESULTS AND DISCUSSION:

By analysing the different types of connections, the equivalent and the maximum shear stress the connections can take are as follows

Table 2 : Equivalent stress under loading:

Types of connection	Equivalent stress (Mpa)		
	100KN	150KN	200KN
Plain surface connection	31.339	47.008	62.77
Shearkey connection(23 degree)	32.298	52.807	67.172
Shearkey connection(45 degree)	29.476	53.332	73.625

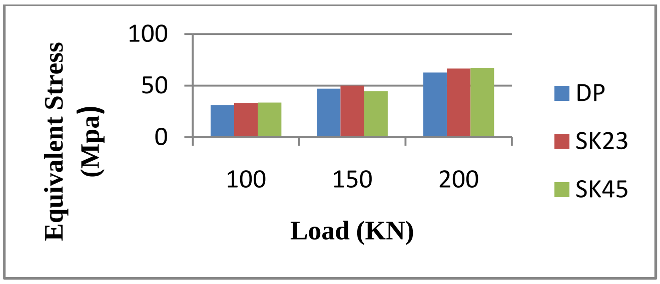

Fig. 5 Equivalent stress in types of connections under loading

Table 3 :Shear stress under loading:

Types of connection	Shear strss(Mpa)		
	100KN	150KN	200KN
Plain surface connection	16.255	24.383	32.54
Shearkey connection(23 degree)	17.512	26.268	35.024
Shearkey connection(45 degree)	17.662	25.662	43.323

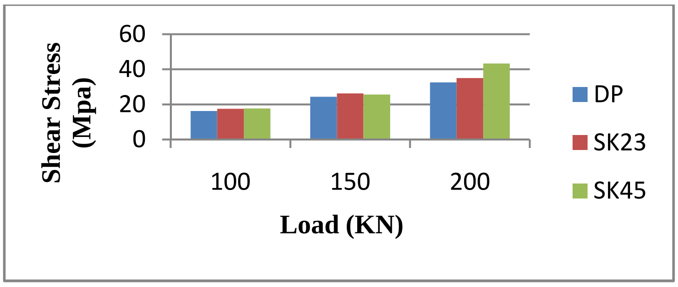

Fig 6 : Shear stress in types of connections under loading:

The experimental results comprises of mechanical properties of concrete are as follows

Compressive Strength of Cylinder:

Specimen: Cylinder

Dimensions: 150mm X 300mm

Table 4 : Compressive strength of cylinder

Sample	Weight(Kg)	Load(kN)	Stress(N/mm2)	Average
1.	13.520	583.2	33.1	24.02
2.	12.950	264	14.95	

Concrete Cube Testing:

Grade of concrete : M40

Dimensions : 100mm x 100mm

Table 5 :7rd DAY TESTING

Sample	Weight (Kg)	Load (kN)	Strength (N/mm2)
1.	8.95	705	31.33
2.	8.70	723	32.13
3.	8.75	810	36

Table 6 :28th DAY TESTING

Sample	Weight (Kg)	Load (kN)	Strength (N/mm2)
1.	8.666	952	42.3
2.	8.344	759	33.73
3.	8.737	958	42.58

Split Tensile Test

SPECIMEN : Cylinder

MATERIAL : Concrete

DIMENSIONS : 150mm X 300m

Table 7 :split Tensile Test

Sample	Weight (Kg)	Load (kN)	Strength (N/mm2)	Average
1.	13.021	175	2.48	2.855
2.	12.330	328	3.23	

Young's Modulus test:

Specimen: Cylinder

Dimensions: 150mm X 300mm

Table 8 :Youngs modulus

Load (Kn)	Displacement		Average strain	Stress (Kn/mm2)
	1	2		
0	0.525	0.425	0.475	0
10	0.492	0.390	0.441	0.000056
20	0.535	0.356	0.445	0.00011
30	0.500	0.362	0.431	0.00016
40	0.490	0.402	0.446	0.00022
50	0.468	0.365	0.416	0.00028
100	0.533	0.357	0.445	0.00056
150	0.553	0.422	0.4875	0.00084
200	0.517	0.340	0.428	0.00113
250	0.479	0.253	0.366	0.00141
300	0.445	0.291	0.368	0.00169
350	0.485	0.353	0.419	0.00198
400	0.400	0.242	0.321	0.00226
450	0.486	0.245	0.365	0.002254
500	0.454	0.204	0.329	0.00282
550	0.422	0.209	0.315	0.00311
600	0.475	0.244	0.359	0.00339
650	0.368	0.115	0.2415	0.00367
700	0.333	-0.017	0.158	0.00396

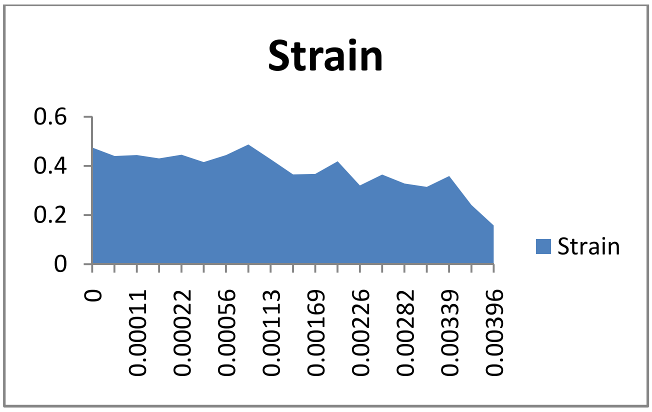

Fig 7: Stress vs Strain graph

VII. CONCLUSION

On applying loads up to 200 KN, it is observed that the connection provided for the panels are intact except for some micro cracks. On increasing loads above 200 KN it is observed that the cracks are formed in the panels while the connection still takes the load. So it can be concluded that the provided connection is more than adequate to resist shear load produced during earthquakes. The connection configurations can be used for practical purposes.The experimental results were found compromising with the analytical results.

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