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Handling Analysis of Precast Concrete Sandwich Wall panels using LEC wall

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Abstract — *This paper summarizes the research work on the Handling analysis of the precast sandwich wall panels to find out the effects of loads as the panel is transported to the site and erected with crane. Handling Stress Analysis and creation of handling diagrams are critical for safe handling of panels in both yard and job site and for choosing the lifting point of panel. In this paper Modeling and Handling analysis are done by LECwall software*

Keywords- *Precast Wall panels, Sandwich wall panel, Handling capacity Analysis, LECwall*

I. INTRODUCTION

Precast concrete wall panels gained popularity due to its speed of erection, design flexibility, thermal efficiency, competitive cost etc. Precast Concrete Wall Panels are cast in the yard, then cured in a controlled environment, then transported to the construction site and lifted with crane.

Sandwich wall panels are made with two outer concrete layers separated by a rigid insulation. Sandwich wall panels are of non-composite, partially composite and fully composite types. In non-composite panel, the concrete layers act independently. In fully composite panels, the concrete layers act together for transfer of horizontal shear. Partially composite panels provide less shear transfer between layers. Pre-stressed steel strands are provided in these panels to withstand tensile forces.

Handling analysis of wall panels is crucial since the handling of wall panels during stripping from formwork; trucking and erecting induce stresses in the wall panel. These stresses should be considered while designing a precast wall panel. The calculation of ultimate capacity, crack resistance, handling stresses and moments in the wall panels are also important while designing the wall panel.

The wall panels can be handled either by standard two point picking or standard four point picking. Strain compatibility is used to determine the member's ultimate capacity in the horizontal position for both positive and negative moment.

II. SOFTWARE USED

2.1. LECwall (Losch Edward Company wall)

LECWall is a Precast or Prestressed wall panel analysis and design software. With this software complete handling analysis under service and ultimate conditions with two or four point pick and user specified form and impact factors can be done easily.

III. MODELLING OF WALL PANEL (AS PER PCI HANDBOOK [6])

3.1. Defining of section properties

Thickness of wall panel = 8in
Outer layer = 3in
Inner layer = 3in
Insulation layer = 2in
Width of the panel = 96in
Length of the panel = 360in
Size of opening = 30x30in

Figure 1 shows the cross section of precast sandwich wall panel.

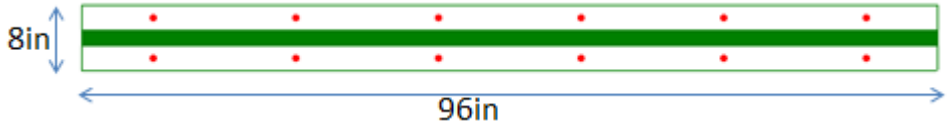

Figure 1: Precast sandwich wall panel

3.2. Defining Material Properties

Grade of concrete = 5000 psi
Grade of Pre-stressing Strands = 60 ksi
Cracking stress coefficient = 7.5 (ACI 318-9.5.2.3)

3.3. Defining Pre-stressing Strands

Diameter of Pre-stressing Stand = 0.375in
Number of Pre-stressing Strand = 12

3.4. Defining Loads

Wind load = 160 plf
Roof Dead Load = 4 kip
Roof Live Load = 4 kip

3.4 Defining static load multipliers

Table 1: Static load multiplier

Condition	*Multiplier on static load*
Stripping	1.3
Trucking	1.5
Erection	1.2

IV. HANDLING ANALYSIS

4.1. Ultimate capacity of wall panels during handling

Figure 2 shows the variation of ultimate capacity of wall panels with respect to increase in composite nature of wall panel during handling.

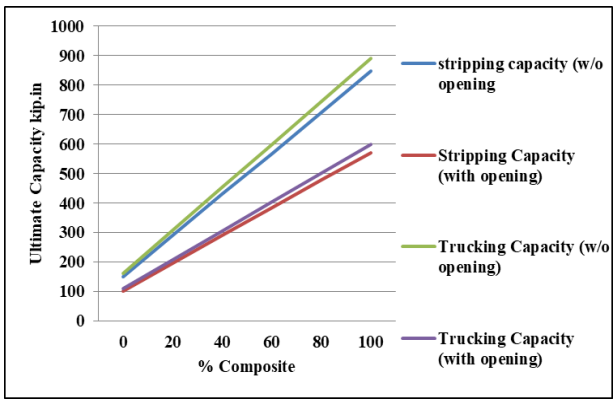

Figure 2: Ultimate capacity versus % composite graph

4.2. Crack resistance of wall panels during handling

Figure 3 shows the variation of crack resistance of wall panels with respect to increase in composite nature of wall panels during handling

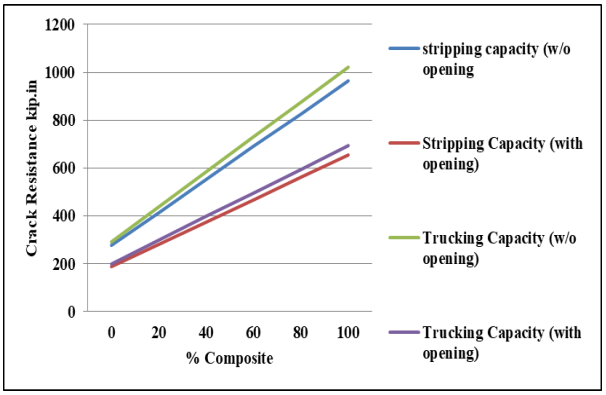

Figure 3: Crack Resistance versus % composite graph

4.3. Handling stress of wall panels

Here bottom layer of concrete is considered as main structural layer. Figure 4 shows handling stresses of wall panels during stripping at top of the panel with respect to increase in composite nature of the wall. Figure 5 shows handling stresses of wall panels during stripping at bottom of the panel with respect to increase in composite nature of the wall. Figure 6 shows handling stresses of wall panels during both trucking and erecting at top of the panel with respect to increase in composite nature of the wall. Figure 7 shows handling stresses of wall panels during both trucking and erecting at bottom of the panel with respect to increase in composite nature of the wall

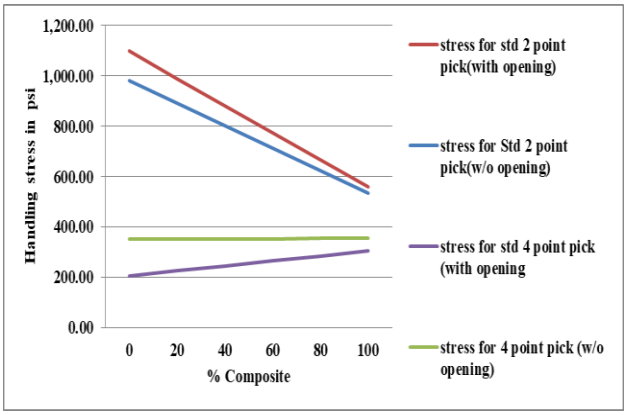

Figure 4: Handling stress at bottom of panel during stripping versus % composite graph

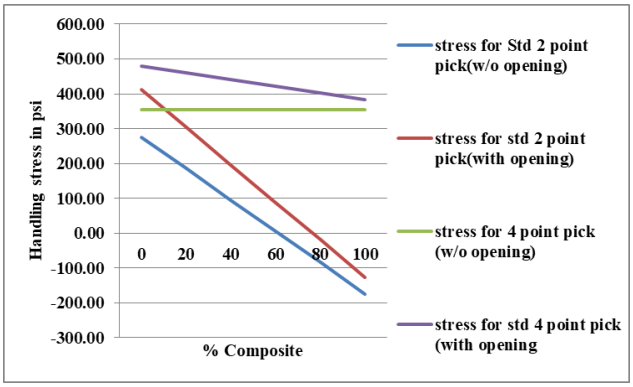

Figure 5: Handling stress at top of panel during stripping versus % composite graph

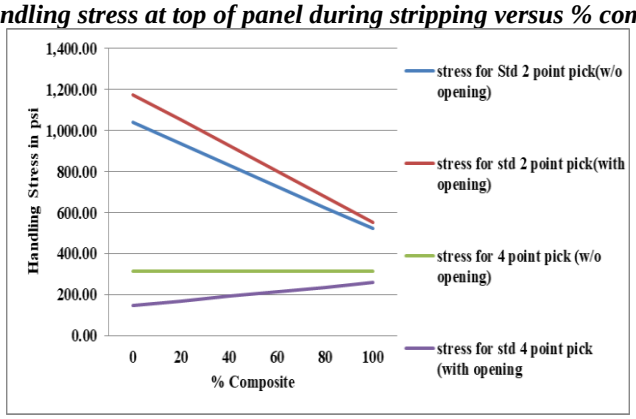

Figure 6: Handling stress at bottom of panel during trucking & erection vsus % composite Graph

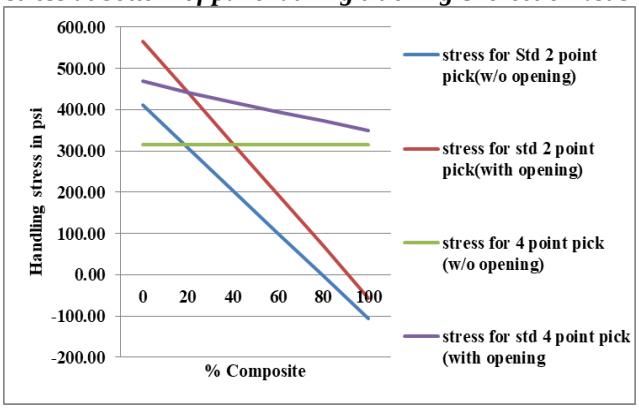

Figure 7: Handling stress at bottom of panel during trucking & erection versus % composite graph

4.4. Allowable stresses in the wall panel

Figure 8 shows variation of tensile stress and compressive stress for both stripping and trucking or erecting operations respectively.

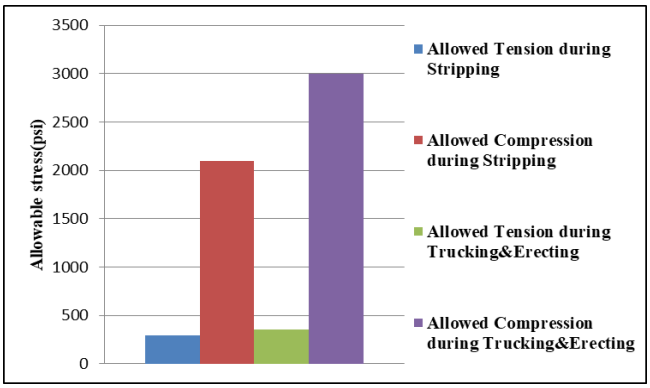

Figure 8: Allowable stresses in wall panels during stripping and trucking or erection

4.5. Factored moment of wall panel

Figure 9 shows variation of Factored moment for both standard two point pick and standard four point's pick of wall panel during stripping and trucking or erecting respectively. It also compares factored moments for panel with and without openings

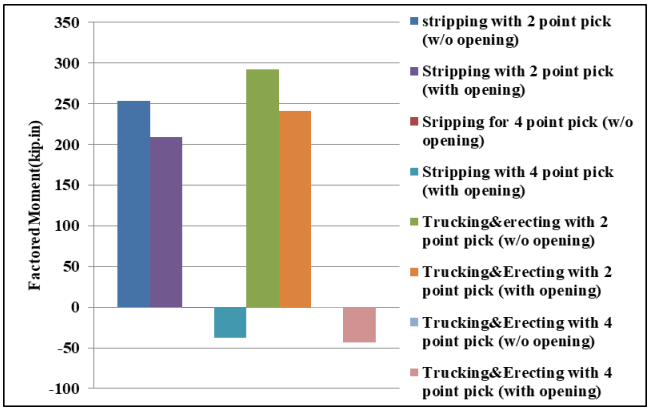

Figure 9: Factored moment of wall panels during stripping and trucking or erection

4.6. Shear force of wall panel

Table 2 shows shear force of precast sandwich wall panels with respect to standard picking points and openings provided

Table 2: Shear force of sandwich wall panel

Shear force(kip)			
Without opening		*With opening*	
Two point pick	*Four point pick*	*Two point pick*	*Four point pick*
0.05	0.05	0.13	0.12

4. CONCLUSION

From the graphs the ultimate capacity and crack resistance of precast sandwich wall panels linearly increase with increase in composite nature of the wall panel. This was because composite panels have more stiffness therefore ultimate capacity and crack resistances are more. The ultimate capacity and crack resistance get reduced when openings are provided in the panel because the openings provide high compressive stresses.

Handling stress of panels with standard two points pick decrease with increase in composite nature and has more stresses in panels with opening than panels without opening. Stress is constant for panels with standard four point pick without opening irrespective of its composite nature because there is less distance between the picking location, so the bending moment get reduced and stress remain almost constant. The main structural layer of concrete has more stress for the panel with opening than panel without opening in case of standard four points pick.

Allowable tensile and compressive stress of panel during trucking or erecting is more than that during stripping of panel. Also the allowable compressive stress is more than allowable tensile stress since pre-stressed strands are used

Factored Moment of panels for standard two point pick is positive and standard four point pick is negative. For four points pick, the distance between the picking point is less therefore moment gets reduced. Factored moment of wall panels gets reduced with opening.

Shear force is constant for panel without opening irrespective of number of picking point of panel but for panel with opening shear force changes with respect to number of picking point

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