Percent Composite Action at Ultimate in Sandwich Wall Panel Connectors

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Introduction

- Current design of concrete sandwich wall panels (SWP) relies completely on recommendations made by connector manufacturers for the percent of composite action to use in design- many engineers feel uneasy relying on these values because they can't check the capacity of these walls themselves
- Composite action is the degree that the two concrete wythes act as a single unit
- Six full-scale SWPs were tested to determine percent composite action of three connector configurations

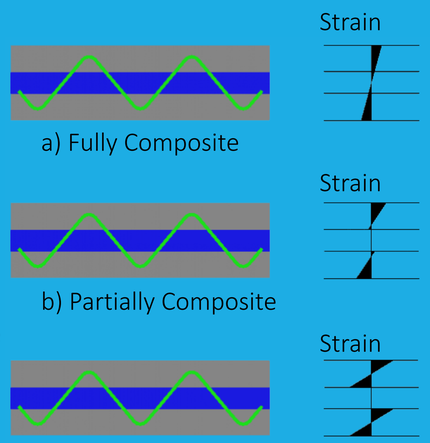
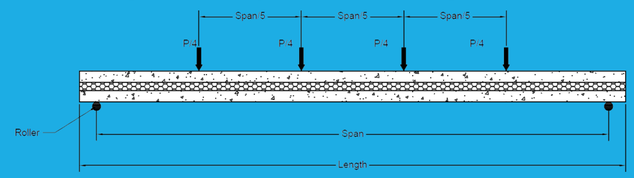
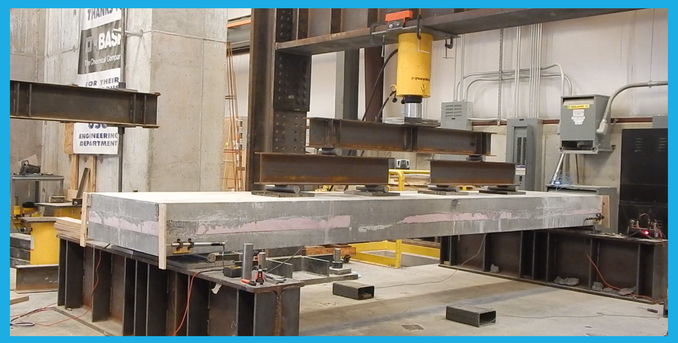


Figure 1- Composite Action Strain Profiles

Test Setup

- Panels were simply supported with distributed load
- Relative slip between wythes measured at panel corners



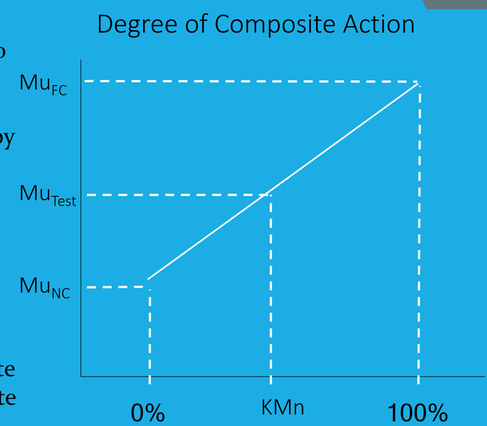


Test Results and Analysis

- Material Testing performed in accordance with ASTM C39 (concrete compression strength) and ASTM A370 (rebar tensile strength)
- Percent composite action calculated by linear interpolation:

$$K_{Mn} = \frac{M_{n,test} - M_{n,NC}}{M_{n,FC} - M_{n,NC}}$$

Where the moments, M, are
- $M_{n,test}$ = experimental measure
- $M_{n,NC}$ = theoretical non-composite
- $M_{n,FC}$ = theoretical fully composite



- Composite action greater than 100% is not possible- calculations of such are due to random error from variability of material properties, analysis model, etc.

Specimen	Wythe Configuration (in-in-in)	M_{nFC} (lb-ft)	M_{nNC} (lb-ft)	Test % Composite Action (%)	Manufacturer Reported % Composite Action (%)
THiN Wall 343-2	3-4-3	55,000	15,800	70%	-*
THiN Wall 343-4	3-4-3	55,000	15,800	115%	100%
HK Composites 1	4-3-4	44,100	12,800	104%	80%
HK Composites 2	4-3-4	43,400	12,200	97%	80%
Thermomass 1	4-3-4	44,100	12,800	103%	70%
Thermomass 2	4-3-4	43,400	12,200	93%	70%
* Purposely reinforced lower than usual – not a typical panel					

Specimen Connector Configurations

- All panels fabricated with glass fiber-reinforced polymer (GFRP) connectors and extruded polystyrene (XPS) insulation
- 2 panels fabricated by Concrete Industries (Lincoln, NE) and 4 panels fabricated by Forterra Structural Precast (Salt lake City, UT)

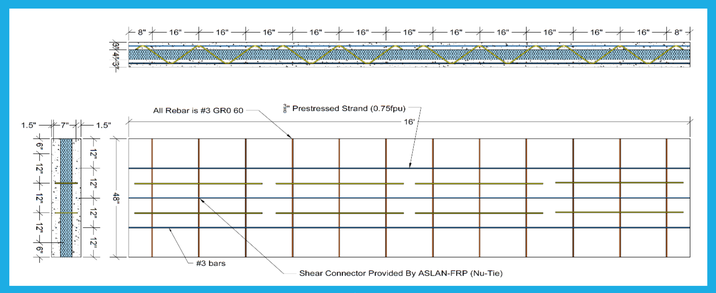


Figure 2- THiN Wall 343-2 Panel (connectors at lower level than recommended by manufacturer)

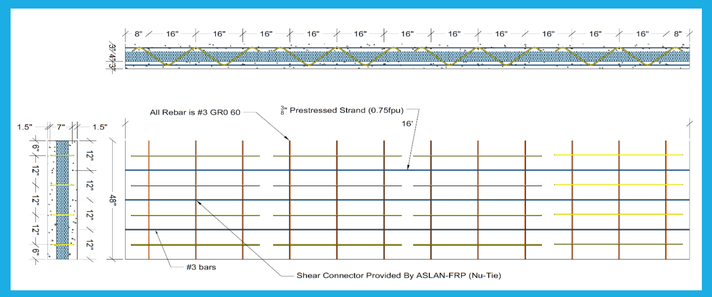


Figure 3- THiN Wall 343-4 Panel

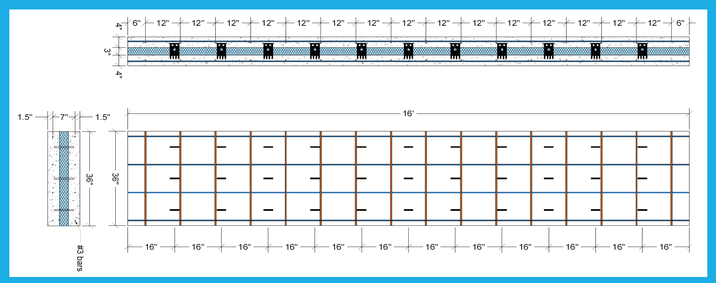


Figure 4- HK Composite Panels

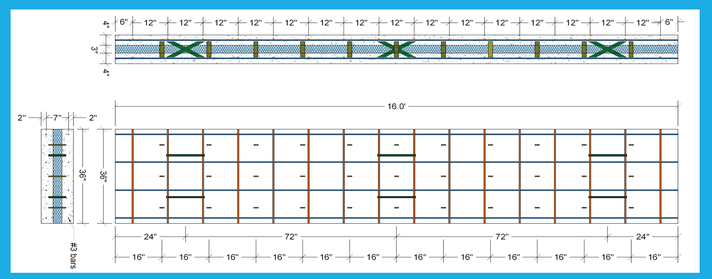


Figure 5- Thermomass Panels

Conclusions

- Type and intensity of shear connectors significantly affect the degree of composite action in concrete sandwich wall panels
- Manufacturer reported degree of composite action is considered conservative

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