IMPACT OF INSULATED CONCRETE BALCONY CURB ON INTERIOR CONCRETE SURFACE TEMPERATURE

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ABSTRACT

Energy efficiency and thermal comfort considerations in high-rise residential buildings are increasingly calling for a thermally broken cantilevered concrete balcony slab at projecting balconies. Thermal breaks are not readily adopted by the local industries who are seeking cost effective means to improve human thermal comfort at such locations. In the last two decades, there were many attempts to adopt certain applications and in the recent years, imported thermal breaks technologies have been used, however, still facing difficulties due to cost.

This presentation reports on previous thermal break methodologies used by the local industries and reports on the work which used alternative detail of an insulated concrete curb condition at the sliding balcony door [1] to improve indoor human thermal comfort conditions in the absence of thermally broken cantilevered concrete balcony slab. Roppel and Norris investigated and analyzed an important construction detail of a sliding door supported directly on an insulated raised concrete curb that has achieved significant results in terms of a lower overall U-value and higher surface temperature without using a thermal break in the concrete slab [2]. The alternative detail of an insulated concrete curb condition was modeled and simulated in THERM. This presentation describes the practical implementation of the detail. It provides the results from simulation and compares them to results from thermally broken slab conditions using proprietary thermal break technology.

DECRIPTION OF THE SIMULATED ASSEMBLY

Design Details

A typical concrete balcony detail of a door-balcony system of high-rise Multi-Unit Residential Buildings (MURBs) as shown in Figure 1 consists of a concrete floor slab that projects to the exterior though a wall

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assembly that consists of a sliding door assembly. The new sectional detail of the concrete curb as shown in Figure 2 consisted of 12.5 mm depression (curb) in the concrete balcony slab right beneath the sliding door/spandrel panel frame. The depression was filled with a 25.4 mm thick Extruded Expanded Polystyrene (EPS) rigid insulation [1]. The detail incorporated a proprietary thermal break in a few of the simulation scenarios for comparison purposes. Certain dimensions must adhere to the manufacturer requirements in terms of height, thickness and placement of thermal break, cantilever maximum length, and concrete cover for tension bars [3]. These details were adhered to as shown in Figure 3.

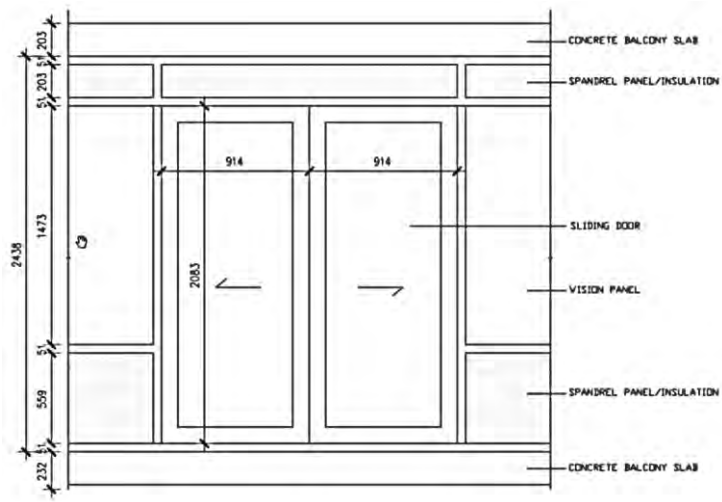

Figure 1: Plan view of standard height floor-to-ceiling window-wall glazing system [1]

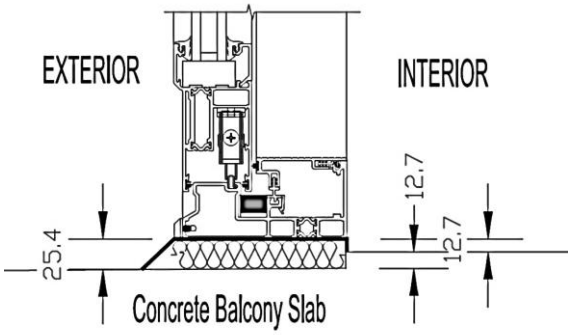

Figure 2: Sectional details of the concrete slab modification with a curb [1]

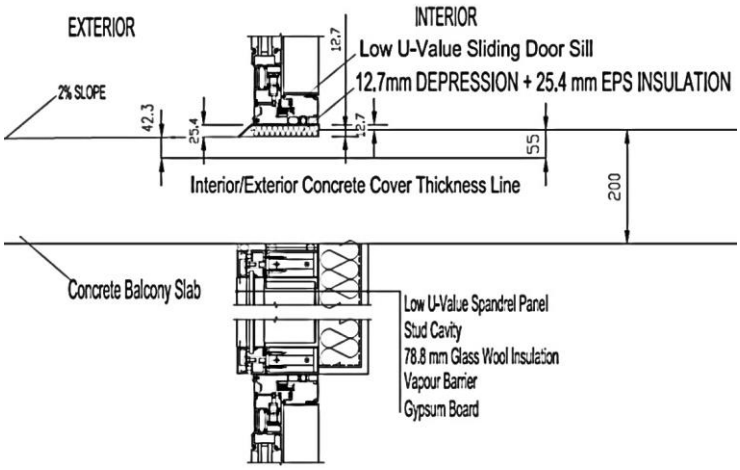

Figure 3: Cross section of the model showing a Lower U-value framed glazing system sliding door above/spandrel panel below [1]

Simulation Scenarios

Table 1 and Table 2 shows the eight scenarios analyzed to evaluate the thermal performance of the concrete slab [1]. Scenarios were grouped into two: Group 1 listed in Table 1a, Group 2 listed in Table 1b [1]. For comparison purposes, the stud cavity for all scenarios was left open with no insulation, and each scenario was remodeled by installing a 78.8 mm (3.1. inches) of glass wool insulation in the frame cavity with an equivalent U-value of 0.481 W/m^2.K and a thermal conductivity of 0.0380 W/m.k [1]. Exterior and interior boundary conditions were used for Toronto's cold climate conditions which are close to the values given in ASHRAE 2009 Handbook-Fundamentals [4].

Table 1: The four scenarios of Group 1 [1]

Scenario Number	Scenario Type	Curb Condition	Glazing Type	Glazing U-Value, W/ m^2.K
1	Conventional	-NA-	Spandrel above and below	0.378
2	Insulated Curb condition	12.7 mm curb with 25.4 mm EPS insulation only	Spandrel above and below	0.378
3	Conventional	Proprietary Thermal Break only	Spandrel above and below	0.378
4	Insulated Curb condition	12.7 mm curb with 25.4 mm EPS insulation and Proprietary Thermal Break	Spandrel above and below	0.378

Table 2: The four scenarios of Group 2 [1]. (above means on topside of the slab and below means underside of the slab)

Scenario Number	Scenario Type	Curb Condition	Glazing Type		Glazing U-Value, W/ m^2.K
5	Conventional	-NA-	above	Sliding door	1.324
			below	Spandrel	0.378
6	Insulated Curb condition	12.7 mm curb with 25.4 mm EPS insulation only	above	Sliding door	1.324
			below	Spandrel	0.378
7	Conventional	Proprietary Thermal Break only	above	Sliding door	1.324
			below	Spandrel	0.378
8	Insulated Curb condition	12.7 mm curb with 25.4 mm EPS insulation and Proprietary Thermal Break	above	Sliding door	1.324
			below	Spandrel	0.378

RESULTS

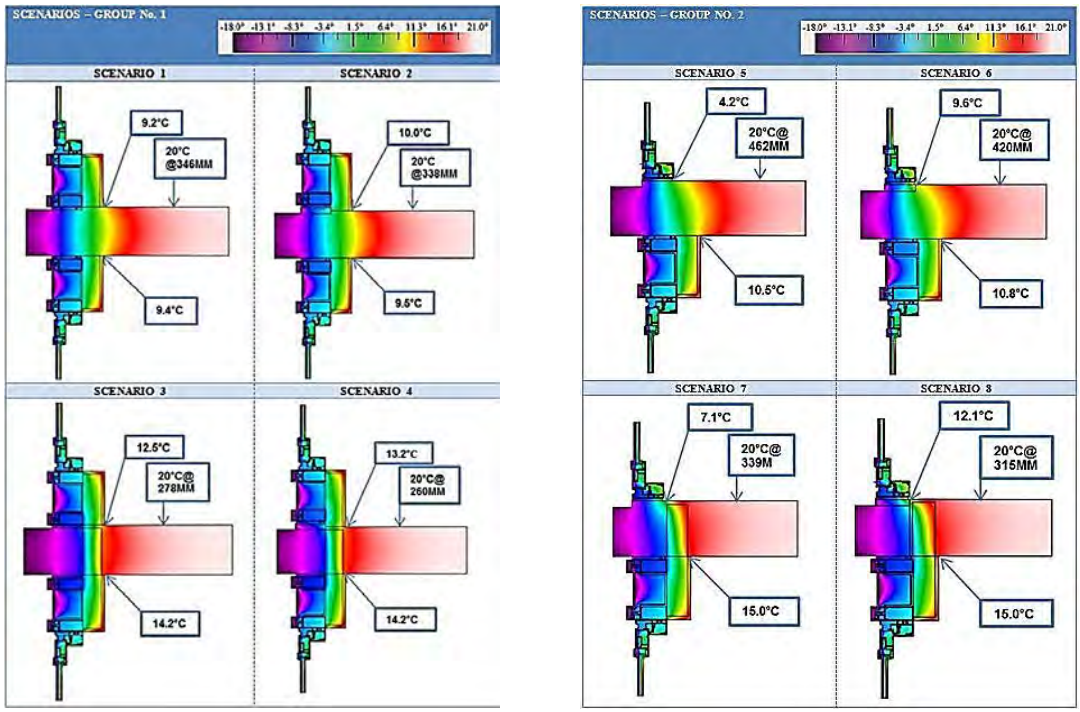

Figure 4: Temperature profile and interior surface temperature at slab/frame intersection of each scenario [1]

Figure 4 shows temperature profiles for the eight modelled scenarios. Also, a summary of the results is presented in Table 2 [1].

Table 3: Interior surface slab temperatures for the eight modelled scenarios [1]

Scenario	Above Balcony	Below Balcony	Length Until 20° C	With Cavity Insulation	
				Above	Below
1	9.2° C	9.4° C	346 mm	9.6° C	9.7° C
2	10.0 ° C	9.5° C	338 mm	10.5° C	10.2° C
3	12.5 ° C	14.2° C	278 mm	13.7° C	15.8° C
4	13.2 ° C	14.2° C	260 mm	14.4° C	16.0° C
5	4.2 ° C	10.5° C	462 mm	4.8° C	11.3° C
6	9.6 ° C	10.8° C	420 mm	9.5° C	11.6° C
7	7.1 ° C	15.0° C	339 mm	7.0° C	16.7° C
8	12.1 ° C	15.0° C	315 mm	11.0° C	16.7° C

The results showed significant increase in interior surface from 4.2° C to 9.6° C for Scenarios 5 and 6 respectively, when the insulated curb condition was incorporated. The interior slab length when 20° C was reached decreased by 42 mm when the insulated curb was introduced. Similar significant increase was seen from 7.1° C to 12.1° C for Scenarios 7 and 8 when the insulated curb condition was incorporated in addition to the proprietary thermal break as well as a decrease of 24 mm in length until 20° C. Also, adding 77.8 mm of glass wool insulation in the stud cavity had no significant change in the thermal performance [1].

CONCLUSIONS

The results indicated that the concrete surface temperature had the tendency to increase and even doubled

when using a lower U-value framed glazing door assembly along with the insulated depression (curb) condition solution of 12.7 mm in concrete slab and 25.4 mm thick EPS rigid insulation in conventional concrete balcony scenarios. This also indicated that there is an alternative construction detail other than the option of using a proprietary thermal break in concrete balcony slab that could provide similar benefits to human comfort in lieu of increasing interior concrete surface temperatures and minimize the risk of condensation [1].

REFERENCES

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