A Passive House mosaic for a NYC urban infill residential retrofit and extension

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1 Introduction

New York City's beautiful townhouses require careful treatment in order to participate in a sustainable future. Our townhouse renovation in Manhattan faced typical constraints in an urban infill environment - structural deficiencies in the existing masonry construction, limited potential for solar heat gain in the winter and restrictive fire codes. This led us to develop a mosaic of different building assemblies (poured-in-place concrete, concrete masonry units, structural steel, light gauge metal, timber frame, rain screen and solid masonry) in order to reach EnerPHit Component certification targets.

2 Building assemblies: site-specific requirements

For the new building envelope, even though it would have been much more straight forward to use the same framing system throughout, since we were trying to maximize the thermal performance of every square inch, we mixed things up a bit and ended up, in total, with 7 different exterior wall types. For the front and rear extensions, the building code allowed us to take advantage of the higher thermal performance of wood framing. With the rear of our horizontal extension, structurally, we had a full height steel moment frame and the wood was only used for the wall infills. For our party wall extensions, the building code required our construction to be completely non- combustible. Rather than continuing up with masonry, we chose structural steel and light gauge metal framing in order to maximize the insulation value of the wall while minimizing its thickness. Thus, we were able to achieve u- value of 0.15 (w/m2k) (R38) with a 30 cm (12 inch) thick framed wall instead of a 45 cm (18 inch) thick masonry wall. Given our constrained building width of 5.8 m (19 feet), this was a significant difference for the project.

Figure 1: Main constraints: adding 1 ½ stories to a 1910 building and insufficient solar potential

Wall Assembly	Purpose	Exterior Finish and orientation		Insulation type and location Note: all service cavities are also insulated	U-value Assembly W/(m²K)
Existing brick	Preserve existing facade	N	Brick	Mineral wool interior	0.266
Existing stone masonry	Preserve existing facade	N	Masonry	XPS and mineral wool interior	0.180
New structural steel A) within timber framing B)6x3 within light gauge framing	Best structural capacity	N E W	Rainscreen	Cavity and continuous exterior mineral wool	A) 0.147 B) 0.222
New timber frame	Best u-value where allowed by code (front and rear facades)	N S	Rainscreen	Cavity and continuous exterior mineral wool	0.105
New light gauge metal	Meets fire code requirements at party wall	E W	Rainscreen	Cavity and continuous exterior mineral wool	0.150
Poured -in -place concrete	Structural capacity transition existing masonry and new steel construction.	E W	Rainscreen	Continuous Exterior Mineral Wool	See THERM drawing
Concrete masonry units	1 wythe added to remediate insufficient existing brick party walls	E W	Only interior	N. A., within conditioned space	N.A.

Table 1: Purpose and performance of wall assembly types

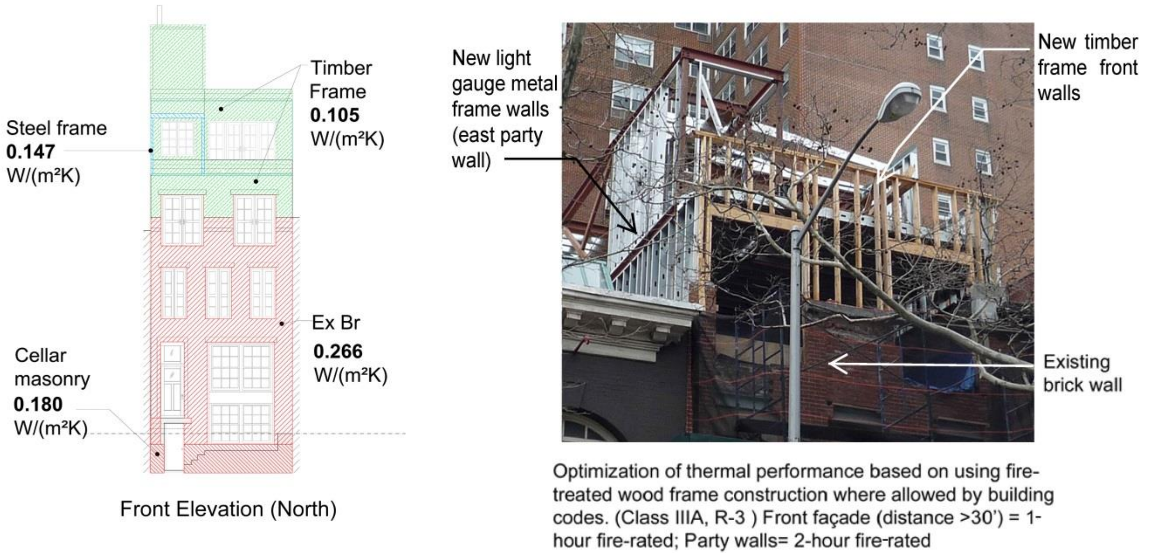


Figure 2: Front façade showing optimization of wall assemblies

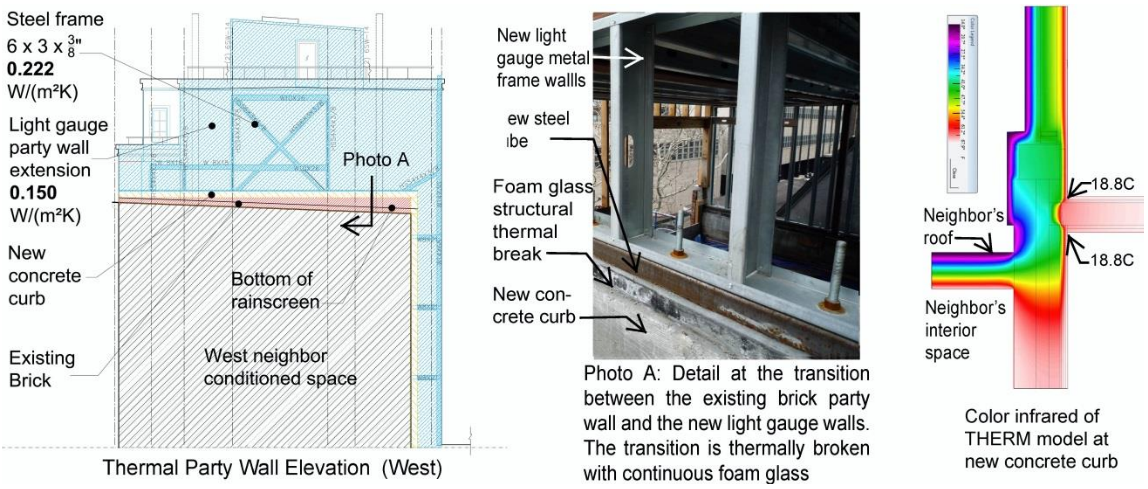
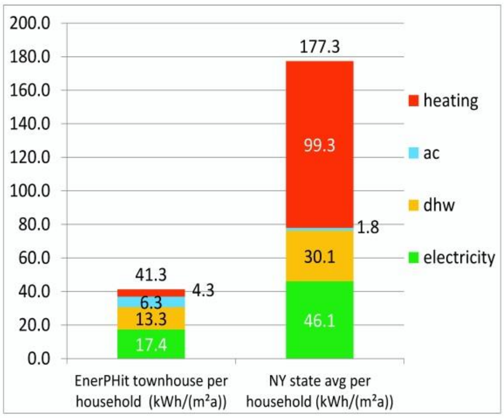


Figure 3: Optimization of wall design at the transition between existing and new construction

3 Conclusion



Based on our PHPP modeling, we are meeting the requirements of EnerPHit Component Certification (PE=123.75 kWh/(m^2a) < 126 kWh/(m^2a) target), as well as improving the average per m^2 energy use by more than a factor of 4 over a typical New York state household. While the usual goal in construction is to simplify the building process as much as possible, with the particular challenges we had in this case, along with Passive House goals in urban contexts, we found that a mosaic of construction types gave the best results.

Table 2: Comparison of our EnerPHit NYC townhouse with NY state average yearly energy use per household per m^2