Retrofitting with a Mosaic of ASSEMBLIES

New York City's beautiful townhouses require careful treatment in order to participate in a sustainable future. Our townhouse renovation in Manhattan faced constraints typical of an urban infill environment: structural deficiencies in the existing masonry construction, limited potential for solar heat gain in the winter, and restrictive fire codes. Nevertheless, after completing this Passive House retrofit, we improved the average energy use per square foot by more than a factor of 4 compared to a typical New York State household.

Chuck Baker Photography

For our work, we decided to use the Passive House Institute's component certification approach to an EnerPHit project, which relies on incorporating assemblies that meet preexisting criteria for a given climate. Unfortunately, we faced more than the usual complications inherent in every retrofit and couldn't rely on just one assembly for all of our walls. Therefore, to maximize the thermal performance of every square inch and solve a host of design issues, we developed a mosaic of seven 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 our component certification targets.

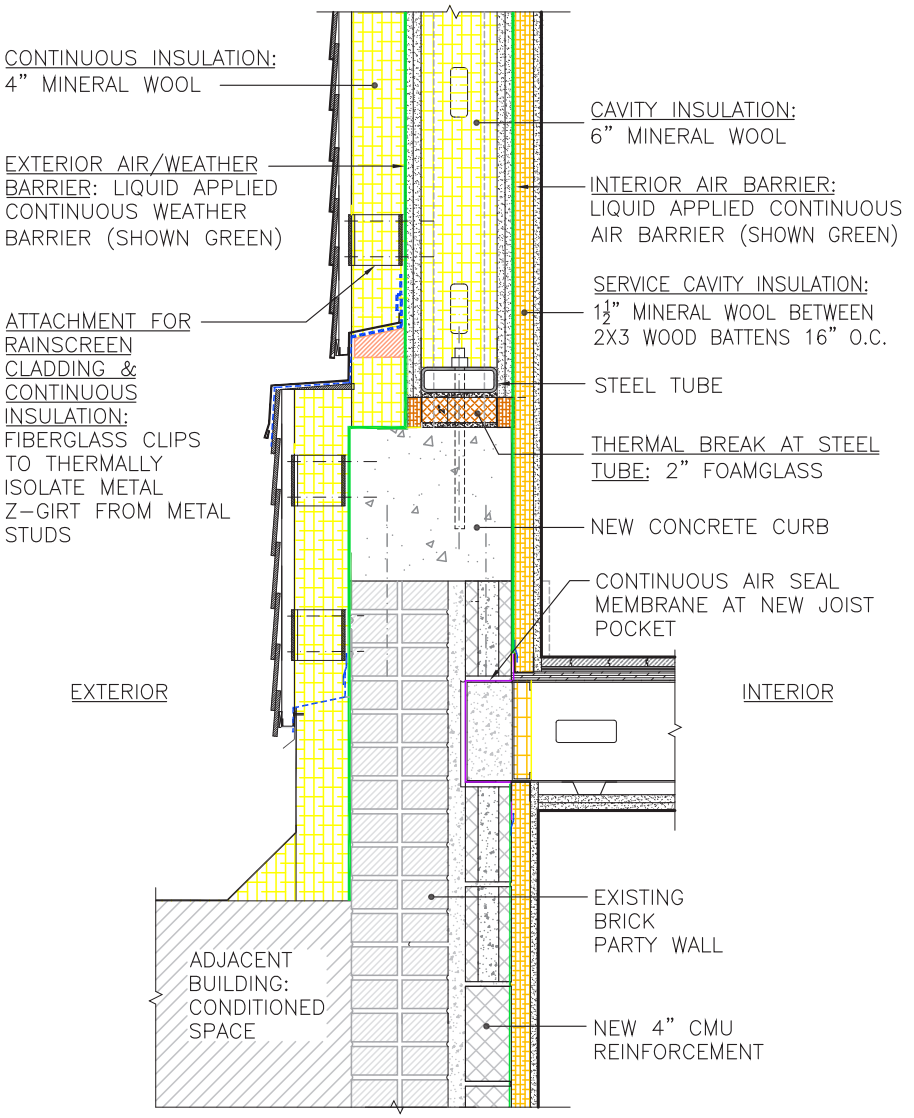
For the front and rear extensions, the building code allowed us to take advantage of the higher thermal performance of wood framing. The rear horizontal extension incorporated a full-height structural steel moment frame, and wood was only used for the wall infills.

For our party wall extensions, the building code required our construction to be completely noncombustible. Rather than continue 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. Using this approach, we were able to achieve an R-value of 38 with a 12-inch-thick framed wall instead of an 18-inch-thick

Table 1: Purpose and performance of wall assembly types

Wall Assembly	**Purpose**	**Exterior finish and orientation**		**Insulation type and location** Note: all service cavities are also insulated	**R-Value hr. ft² F/ Btu**	**U-value Assembly W/(m²K)**
Existing brick	Preserve existing facade	N	Brick	Mineral wool interior	21.34	0.266
Existing stone masonry	Preserve existing facade	N	Masonry	XPS and mineral wool interior	31.54	0.180
New structural steel A) within timber framing B)6x3 within light gauge framing	Best structural capacity	N E W	Rain-screen	Cavity and continuous exterior mineral wool	38.62 25.57	A) 0.147 B) 0.222
New timber frame	Best u-value where allowed by code (front and rear facades)	N S	Rain-screen	Cavity and continuous exterior mineral wool	54.07	0.105
New light gauge metal	Meets fire code requirements at party wall	E W	Rain-screen	Cavity and continuous exterior mineral wool	37.85	0.150
Poured-in -place concrete	Structural capacity transition existing masonry and new steel construction.	E W	Rain-screen	Continuous Exterior Mineral Wool	See THERM drawing	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.	N.A.

Chuck Baker Photography



Detail by John Gibson

masonry wall. Given our constrained building width of 19 feet, this choice made a significant difference.

As one of our early Passive House projects, we began this journey with great faith and deep optimism in the efficacy of the rigorous Passive house principles to provide the most comfortable and energy-efficient living environment possible. Having experienced the full cycle of this process, our architectural studio now applies the Passive House principles to all our projects, whether they will be certified or not.

Moving forward, we have learned that integrating Passive House principles from the very inception of the project is critical for optimal results. Furthermore, at every stage of the project, working in Passive House engenders a strong sense of community through the teamwork required to coordinate among many different trades at various phases. We have come to very much appreciate this social aspect of Passive House, which, we believe, provides a cultural fabric that is socially transformative, economically sound, ecologically productive, and inspiringly beautiful.

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Passive House Metrics

Heating energy	**Cooling energy**	**Total source energy**	**Air leakage**
6.3 kBtu/ft²/yr	2.9	39.2	
1.8 kWh/ft²/yr	0.8	11.5	1.0 ACH_{50}
19.8 kWh/m²a	8.9	123.8	