Innovative Composite Wall System
for Sheathing Masonry Walls

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Innovative Composite Wall System
for Sheathing Masonry Walls

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BACKGROUND

Existing Housing - Much of the older multifamily housing stock in the United States includes units in structures with uninsulated masonry walls. Included in this stock are two- and three-story walk-up apartments, larger apartment complexes, and public housing (both high-rise and townhouse).

This older multifamily housing has seen years of heavy use that may have left the plaster wall marred or damaged. Long-term building settlement or movement may have cracked the plaster, sometimes severely. Moisture from unvented kitchens and baths may have caused condensation on uninsulated exterior walls. At best this condensation has left stains on the paint or wallpaper. At worst it has supported mold and mildew growth, fouling the air and creating unhealthy living conditions.

Deteriorating plaster and flaking paint also result from wet walls. The presence of flaking, lead-based paint in older (pre-1978) housing is a major public health concern. Children can suffer permanent mental handicaps and psychological disorders if they are subjected to elevated levels of lead, while adults can suffer hypertension and other maladies. Studies have found that, in some urban communities with older housing stocks, over 35% of children tested have elevated blood lead levels (Hastings, et al.: 1997). Nationally, nearly 22% of black, non-hispanic children living in pre-1946 housing were found to have elevated levels of lead in their blood (MWWR Article: February 21, 1997). The deterioration of many of these walls is to the point that lead can freely enter the living space.

High-space conditioning costs and uncomfortable living conditions also result from a lack of adequate insulation in the walls. Older multifamily housing may also contain old, low-efficiency, furnaces or boilers that further escalate the space-conditioning costs.

Dealing with these problems in existing housing offers opportunities not only for improving the health and comfort of the occupants, but also for improving the energy performance of the units.

While usually less problematic than multifamily housing, existing single family housing
with basements used as living space offer another retrofit opportunity for insulating masonry walls.

*New Housing* - Building codes have begun to dictate the insulation of basement walls in regions of the country with severe winters. While many insulation approaches are in use, each have strengths and weaknesses. The use of foam plastic boards on the exterior of the wall creates the need for non-standard construction details and can also have problems with termites and carpenter ants burrowing through the insulation if it is untreated. The commonly used system of 2x4s, fiberglass batts, and standard drywall placed on the inside of the basement wall consumes 4 inches of living space. This commonly used system also does not withstand the rare instances of "flooding" (i.e., short-term standing water) that basements can experience during their life. This "flooding" can result from a broken pipe, a backed-up drain, or an extended power outage that prevents a sump pump from performing its job.

Providing a basement wall insulation system that is energy efficient at reasonable cost and able to survive potentially adverse circumstances such as periodic standing water is a challenge for new home builders.

**COMPOSITE WALL SYSTEM**

To address the problems of uninsulated masonry walls, a composite wall system has been developed to sheath deteriorated plaster and encase the lead paint hazards on existing wall surfaces while adding a tight, well-insulated, and durable interior surface to perimeter walls. In addition, this system is intended to sheath the interior of both existing and new basement walls.

This lower-cost composite wall system (Figure 1.) is a result of DOE-funded research and development conducted by the Advanced Housing Technology Program at Oak Ridge National Laboratory (ORNL) and the Existing Buildings Efficiency Research Program at Argonne National Laboratory (ANL). In addition to ORNL and ANL, a collaborative effort to demonstrate and field test the system in existing multifamily housing includes the Chicago Housing Authority (CHA), the Louisiana-Pacific Corporation, and the Celotex Corporation. A prototype wall was constructed and tested at CHA headquarters with materials and labor provided by Louisiana-Pacific and Celotex. One housing unit at CHA's Brooks Development has been completed as a field test (Figures 2. & 3.) and several additional units are planned for retrofit with the system. The units' energy performance will be monitored during the 1997/98 heating season. CHA is contributing labor and standard materials for the field test while DOE is providing the "innovative" materials. Discussions were also underway between the National Laboratories and Louisiana-Pacific to identify a potential field test of the system in the basement of a new residential unit.

**MATERIALS**

The wall system includes cellulose-fiber-reinforced gypsum wall board, rigid foam
insulation, an adhesive to bond the components together, metallic tape to seal joints in
the insulation, and wood nailers and fasteners to mechanically fasten the top and bottom
of the system to the existing masonry wall. The specific materials used in the CHA
prototype and field tests are described below.

Louisiana-Pacific's "Fiberbond", a cellulose-fiber-reinforced gypsum wall board, was
chosen for its structural characteristics, impact resistance, and surface durability. The
structural characteristics permit the Fiberbond to be hung from the top nailer of the
system, which results in a straight, true wall, while the foam adhesive is bonding the
system together. Its impact resistance and surface durability are also important
characteristics in tenant occupied units. It is available in many building supply stores.

Celotex "Tuff-R" was selected as the rigid foam insulation because it provided the highest
available R-value within the limited thickness (1-1/2 inch). Tuff-R is a foil-faced,
polyisocyanurate insulation with a stabilized R-value of 8.0 per inch according to the
manufacturer's literature.

"EnerFoarn", made by Abisko Manufacturing, Inc., was selected as an easy to apply,
quick-setting, adhesive which contained no solvents that could destroy the rigid insulation.
EnerFoarn is a one component polyurethane foam with limited expansion.

CONSTRUCTION

The composite wall system is constructed of 1-1/2 inch Tuff-R insulation and 1/2 inch
Fiberbond. The system is installed on the inside face of exterior masonry walls, contains
no vertical studs or nailers, and extends inward only 2 inches from the original wall.
Other retrofit insulation systems, like conventional stud walls, consume 4 inches or more
of living space.

The composite wall is constructed by mechanically attaching two nominal 2 x 2 inch wood
nailers horizontally to the original wall at the floor and at the ceiling. The nailers are
sealed at the wall and at the floor or ceiling with foam adhesive. This prevents lead
contaminated dust from migrating into the living space from under or around the nailers.

A 4 x 8 foot sheet of 1-1/2 inch rigid foam insulation is trimmed to fit between the nailers
against the original wall (approximately 3 inches must be removed). The rigid foam
insulation is attached to the original wall with the foam adhesive. The adhesive is
applied to the rigid insulation in 1/4 inch beads about 12 inches apart. The edges of the
insulation are taped with metallic tape at the vertical seams and at the top and bottom
nailers to provide a continuous air and vapor barrier, and to contain lead dust particles.

The Fiberbond is installed (see Figure 1.) in the following manner for best results. First,
foam adhesive is applied to the exposed surface of the rigid insulation in 1/4 inch beads
about 12 inches apart. Second, two quarter-inch thick shims are placed on the floor in
front of the bottom nailer. Third, the 4 x 8 foot Fiberbond is set onto the shims. The
edge of the Fiberbond should be offset from the edge of the insulation by 6 to 12 inches
so that the seams will not align. This will strengthen the joint in the Fiberbond and will reduce the potential for air and moisture movement into the wall system as well as providing an additional barrier to contain lead dust. Next, the Fiberbond is mechanically attached to the top nailer with six to eight drywall screws while being pressed into the adhesive. Finally, the shims are removed - allowing the weight of the Fiberbond sheet to straighten itself - and the bottom is attached to the lower nailer with three to four drywall screws. The joints of the Fiberbond and drywall screws can then be finished with standard drywall tapes and joint compounds. Standard painting and/or wall papering techniques, along with the installation of a base cove, complete the installation.

IMPACT TESTING

The type of impact testing to which the prototype wall was subjected is shown in Figure 4. The composite wall performed significantly better than typical wall construction of paper-faced drywall supported on 2x4 wood studs and insulated with fiberglass. Damage to the composite wall was a small hairline fracture that was easily repaired with drywall compound. Damage from a similar impact to typical wall construction would require removal of the broken drywall, replacement with a new piece, and extensive patching with tape and drywall compound.

SYSTEM COSTS

The costs of this system have not as yet been fully defined because it has not seen widespread application. A comparison of costs, based on R.S. Means Estimating Guides, of this system with a wood stud, fiberglass batts, and standard drywall installation suggests that the composite system has a total installed cost of about 12% less. In the CHA field test project (Summer 1997), Fiberbond cost $0.355 per square foot and Tuff-R cost $0.60 per square foot. In more moderate climates, a less expensive, lower R-value, rigid foam insulation could be substituted, thereby reducing initial costs while providing an adequate level of thermal resistance.

Contractor estimates vary with the cost of labor (geographically and union/non-union) and the complexity of the actual project (windows, doors, outlets, pipes, etc.). A moderately complex complete installation, including base cover and painting, in Chicago was estimated to cost in the range of $4.20 to $4.90 per square foot (1997 wages), based on professional crafts installation. Given the simplicity of the system, it is believed that this system could be within the capabilities of resident labor crews for public housing developments. The use of semi- or non-skilled labor would significantly reduce the labor costs while providing job experience for public housing residents.

CONCLUSIONS

Important challenges face those involved in renovation of existing and construction of new housing with masonry walls. The cost-conscious, energy-efficient, composite wall system discussed in this paper, that can also address other issues such as the encasement of lead paint while surviving a potentially adverse environment, will provide an important
tool in meeting those challenges.

REFERENCES


Captions:

Figure 1. The construction of the composite wall system is illustrated. Refer to the text for a step-by-step description.

Figure 2. An extended vacancy period coupled with a leaky steam heating system resulted in severe deterioration of the paint and exterior wall plaster in this Brooks Homes unit belonging to the Chicago Housing Authority.

Figure 3. The composite wall system was installed in Brooks Homes on the exterior walls, the first floor slab (4 feet of insulation at the exterior walls), and the roof slab (with full insulation). Deteriorated interior walls were sheathed with the same Fiberbond wallboard but without insulation.

Figure 4. The prototype composite wall was subjected to impact testing to determine how well it would withstand the impact and what would be required to repair the wall. Here a hammer blow has left a dimple in the wallboard joint. Unlike common drywall, there was no "breakthrough" on the back. Repair involved simply filling the dimple with joint compound.