ADVANCED PHENOLIC COMPOSITE TRANSIT VEHICLE FLOOR SYSTEMS:

A REVIEW OF COST REDUCTION THROUGH LIGHTWEIGHT, FIRE SAFE, MOISTURE-RESISTANT PHENOLIC COMPOSITE FLOOR PANELS

NOVEMBER 16, 2011

PREVIOUS USA/NORTH AMERICAN TRANSIT VEHICLE FLOOR Systems:

MAJOR PROBLEMS:

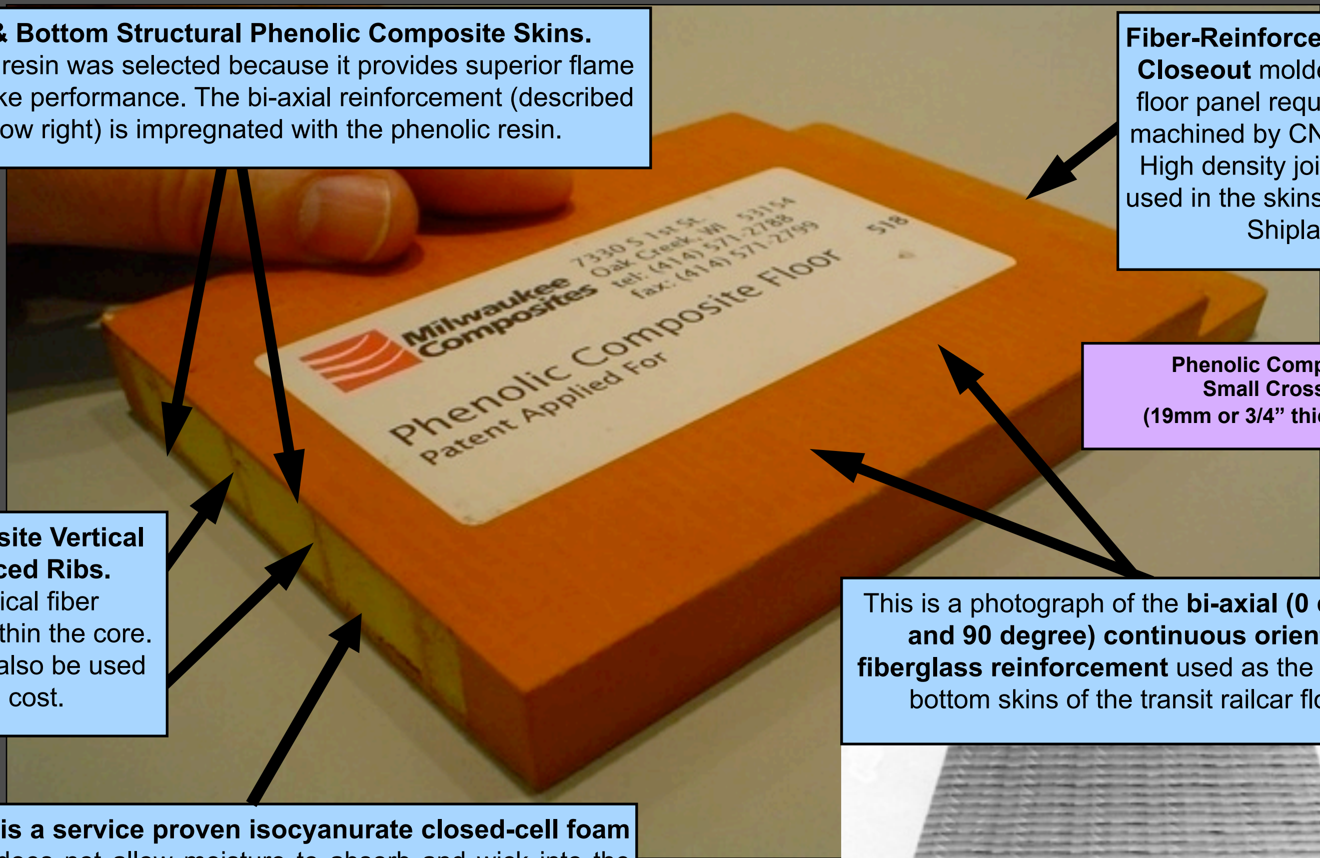
- PLYMETAL and PLYWOOD FLOORING WAS BEING REPLACED EVERY 7 to 12 YEARS *(Moisture intrusion & rotting wood core).* THIS CAUSED EXPENSIVE RETROFIT and MID-LIFE RAILCAR OVERHAULS. FULL FLOOR REMOVAL REQUIRED.
- PLYMETAL and PLYWOOD FLOORS WERE CONSIDERED TOO HEAVY. USA TRANSIT AUTHORITIES DESIRED SIGNIFICANT WEIGHT REDUCTION (ENERGY SAVINGS).
- US DOT (ASTM–E-119/NFPA 130) WAS PROGRESSING TO A THIRTY (30) MINUTE FIRE RATING REQUIREMENT.

1997: AN ENGINEERED SOLUTION:

Phenolic Composite Floor Panel Construction

Top & Bottom Structural Phenolic Composite Skins. Phenolic resin was selected because it provides superior flame and smoke performance. The bi-axial reinforcement (described below right) is impregnated with the phenolic resin.

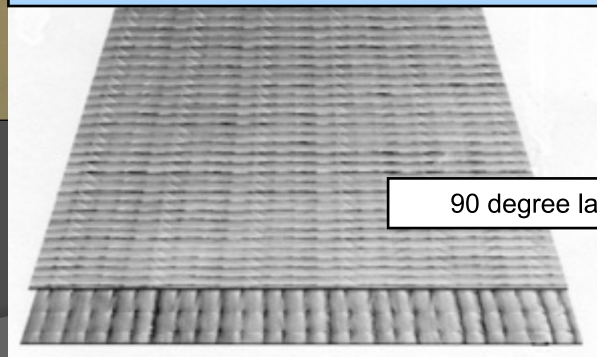
Fiber-Reinforced Phenolic Dense Edge Closeout molded into edges where the floor panel requires a joint. Geometry is machined by CNC after panel is molded. High density joint. Same phenolic resin used in the skins is used in the closeouts. Shiplap or Butt joints.



Phenolic Composite Floor Small Cross-Section (19mm or 3/4" thickness shown)

Phenolic Composite Vertical Fiber Reinforced Ribs. There are vertical fiber reinforced 'ribs' within the core. Balsa Core could also be used for reduced cost.

This is a photograph of the **bi-axial (0 degree and 90 degree) continuous oriented fiberglass reinforcement** used as the top and bottom skins of the transit railcar floor.



90 degree layer

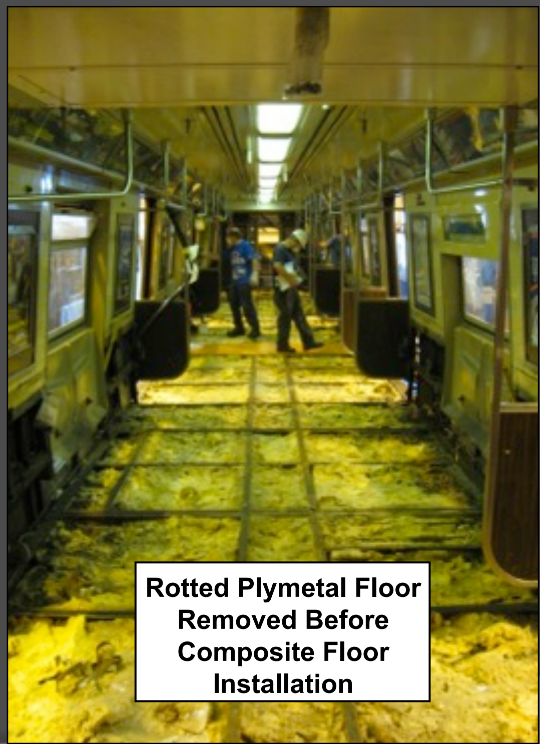
This core is a service proven isocyanurate closed-cell foam core that does not allow moisture to absorb and wick into the core. Millions of closed-cells are bonded against the phenolic composite structural skins, resulting in excellent adhesion to the composite skins. The reinforced isocyanurate core passes BSS 7239 (toxic gas) testing, and ASTM E162 ASTM 662 and ASTM E-119, SMP-800C & BS 6853 Class 1a.

First USA Phenolic Transit Composite Floor:

SEPTA M-4 Railcar (Philadelphia)
Using lightweight, fire-safe phenolic composite floors since 1998.

New York City Transit:

Replacing failed Plymetal floors with Phenolic Composite Floor Panels Engineered to Fit Same Space Envelope (approximately an 800 pound weight savings per car).

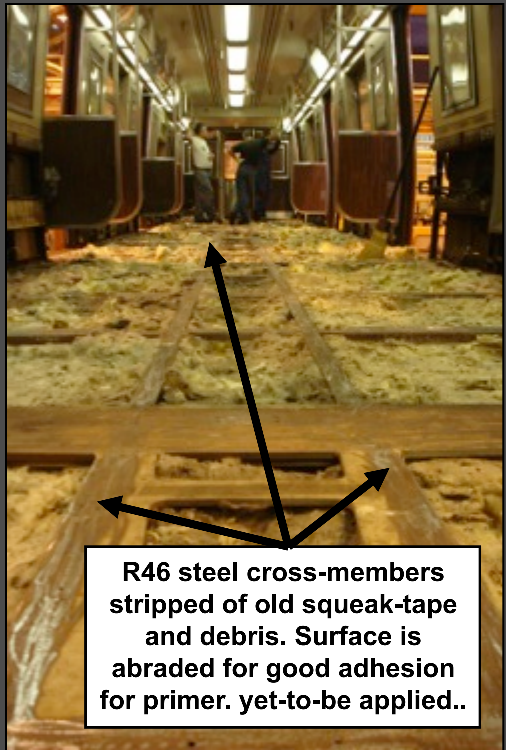


Rotted Plymetal Floor Removed Before Composite Floor Installation

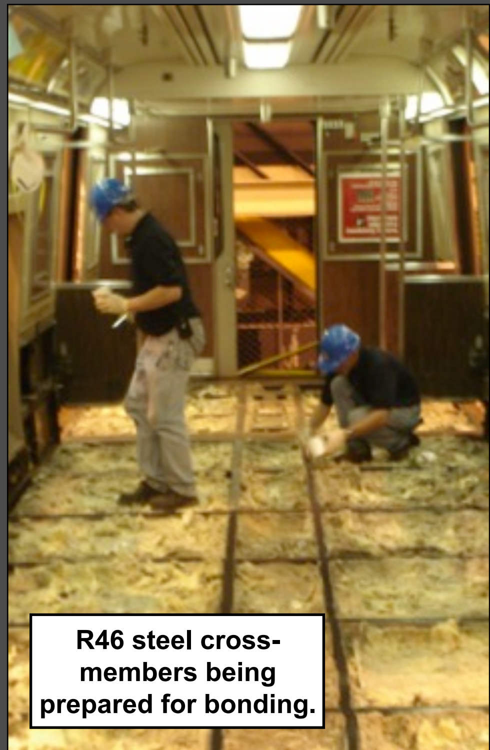
Composite Floors Installed
(Nora Rubber Floor Mat not yet applied)

During Installation

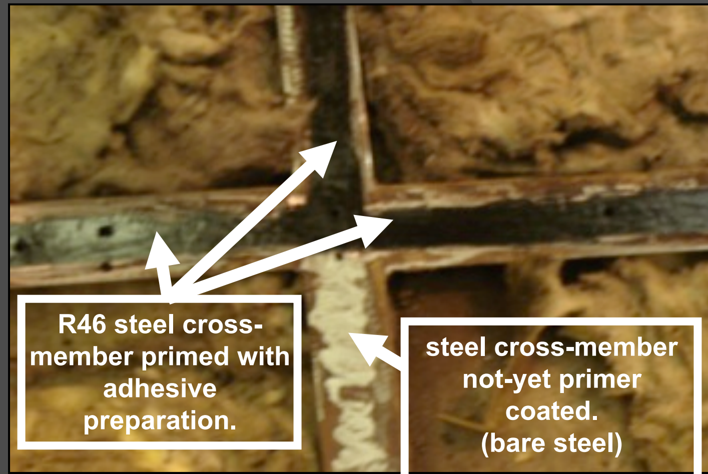
Refurbish Older Railcars: New York City Transit Composite Flooring (R46 Cars Brooklyn, New York)



R46 steel cross-members stripped of old squeak-tape and debris. Surface is abraded for good adhesion for primer. yet-to-be applied..



R46 steel cross-members being prepared for bonding.



R46 steel cross-member primed with adhesive preparation.

steel cross-member not-yet primer coated. (bare steel)

Moisture cure urethane adhesive being applied to underframe. Pneumatic gun dispenser with adhesive cartridges.

Carmen positioning lightweight composite panels down upon adhesive bead. No fasteners used. Only adhesive holds floor to underframe. Allows for excellent sound dampening and fatigue resistance.

R46 composite floors bonded in-place. Car completed. 4.2 hours.

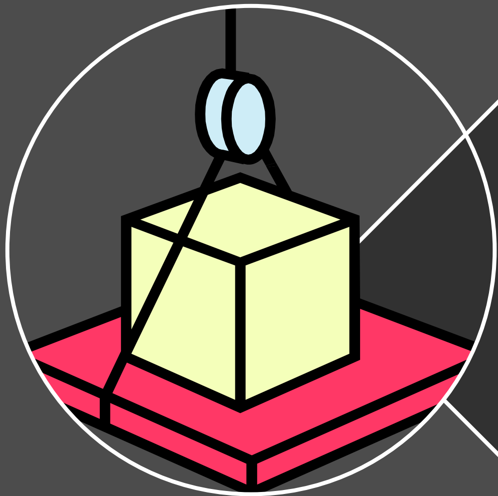
Composite Floors Can Adapt To Any Railcar Construction:

CHARLOTTE, NORTH CAROLINA

PORTLAND, OREGON

Phenolic Composite Transit Floors:

SAVE TRANSIT AUTHORITY ENERGY COSTS



Weight Reduction
(approximately 50% to 65% weight reduction with respect to plywood or plymetal floors. Weight reduction is important in railcar operations).

Composite Floors on NYCT R-160: SAVES **US$ 1,046,854** IN ANNUAL ENERGY COSTS.

NYCT R-160 Project Operating Cost Savings Worksheet

***Note:** Operational Cost Savings Calculated ($) are only from the weight savings provided by MCI floors on R-160 Vehicles.*
Additional operating cost savings are possible from lighter vehicles. (i.e. Break Components, etc…)
Compared to current floor material: MCI floors reduce maintenance costs, improve firesafety and provide longer revenue service.

Formula: **Eliminating 4 tonnes of weight saves 40,000 kWh per 250,000 km traveled.**

See conversion chart below for calculations.

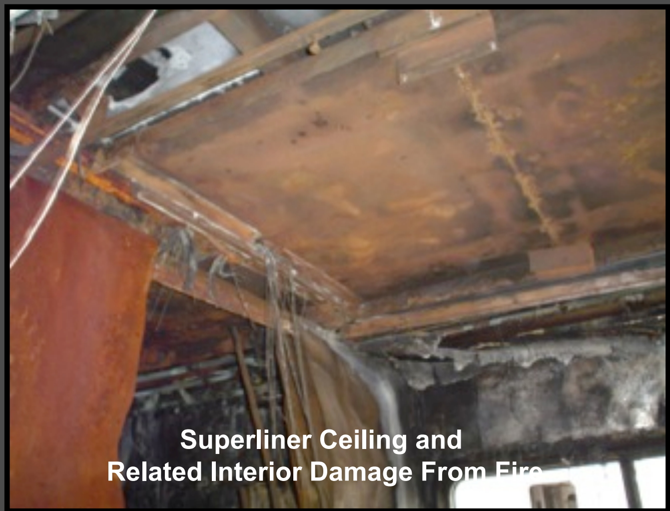
	Value	Unit	Description of Calculation
Weight	**863**	lb.	saved per R-160 Vehicle (projected weight savings with MCI floors per 1 R-160 car)
	2,000	lbs.	per 1 ton (short)
	4.41	tons	weight saved over 250,000km traveled saves 40,000kWh of energy. (per 1 car)
	8,820	lbs.	weight saved over 250,000km traveled saves 40,000kWh of energy. (per 1 car)
Miles	**353,728,000**	miles	miles traveled by NYCT fleet in 2006
	57,053	miles	average annual mileage per one (1) NYCT fleet vehicle.
	250,000	km	traveled saves 40,000kWh of energy per 8,820lbs saved. (per 1 car)
	155,343	miles	traveled saves 40,000kWh of energy per 8,820lbs saved. (per 1 car)
kWh	40,000	kWh	saved per 8,820lbs weight saved over 155,343 miles traveled. (per 1 car)
	1,437	kWh	saved per 863lbs weight saved over 57,053 miles traveled (per 1 R-160 car)
	$0.1175	per	kWh (average NYCT transportation price per kWh)
Vehicles	6,200	cars	approximate total NYCT fleet.
	200	cars	per Alstom R-160 Base Order fleet. (3.23% of total NYCT fleet)
	550	cars	per Alstom R-160 Option Order fleet. (8.87% of total NYCT fleet)
	750	cars	per Alstom R-160 Base Order + Option Order fleets combined. (12.10% of total NYCT fleet)
$	$0.20	/ lb.	$ value per 1 lb. weight saved per 1 Alstom R-160 car with MCI flooring traveling at least 57,053 mi.
	$168.85	**/ yr**	**annual operating $ saved per 1 Alstom R-160 with MCI flooring traveling at least 57,053 miles.**
($) Ext.	**$33,769.50**	**/ yr**	**annual operating $ saved per Alstom R-160 Base Order Fleet using MCI flooring.**
	$92,866.13	**/ yr**	**annual operating $ saved per Alstom R-160 Option Order Fleet using MCI flooring.**
	$126,635.63	**/ yr**	**annual operating $ saved per Alstom R-160 Base + Option Order Fleet using MCI flooring.**
	$1,046,854.50	**/ yr**	**annual operating $ saved per NYCT fleet using MCI flooring (assumes ave. 863 lbs/car saved)**

Phenolic Composite Floors Adapted to Bi-level Heavy Rail (Hyundai-Rotem USA – SCRRA Los Angeles Metrolink)

Passengers Need Fire Safety.

Superliner Car Fire Vehicle

Passenger Interior



Superliner Ceiling and Related Interior Damage From Fire

Superliner Interior Damage From Fire

Worldwide Transit Authorities Are Growing More Concerned About Fire Safety:…they want to make their cars much safer.

COMPARISON of EN to USA FIRE STANDARDS:*

Based on the review of EN 45545-2 test protocols and performance requirements of vehicles compliant with a Fire Protection Level of 3, it cannot be stated that an equivalent level of protection to 49 CFR 238.103 is provided.

In evaluating the potential fire performance of a railcar built to EN standards, it would be important to conduct a complete review of the drawings and materials used in the construction of the car. After a review of the materials, it would be prudent to perform a limited amount of testing on materials suspected to have poor flammability and smoke-emission performance. Testing must be conducted in accordance with the protocols outlined in 49 CFR 238.103. A floor fire test and a complete Fire Safety Analysis package from the car builder would be the final step in the review process.

Conclusion:*

In the final assessment, passenger rail vehicles certified to EN 45545-2 Level 3 Preventive Fire Protection standards should not be expected to meet FRA requirements. Even EN 45545-2 Level 4 vehicles, the highest level of Fire Protection in the EN, would be expected to fall short of complying with U.S. standards

*** Courtesy of LTK Engineering (Ambler, PA) AN Independent Engineering Consultant Group Recognized As One of the World's Most Respected Passenger Railcar Fire Safety Experts.**

ASTM E-119 Fire Endurance Test Simulates a Fire Source Beneath The Passenger Railcar

Thirty (30) Minute Duration is Intended to Allow for Fire Rescue of Trapped Passengers, Especially Within Tunnels

ASTM E-119 Fire Endurance Test: Bombardier Hiawatha Floor Test (Minneapolis, MN)

Test Requires Exact Carbody Underframe be simulated for the test.

Zone of railcar used for this test.

Passenger Load Density.

Fire Endurance Testing Procedures — Page 27 of 31 — FC-594 — 812-BRA-0106 — Revision: 0

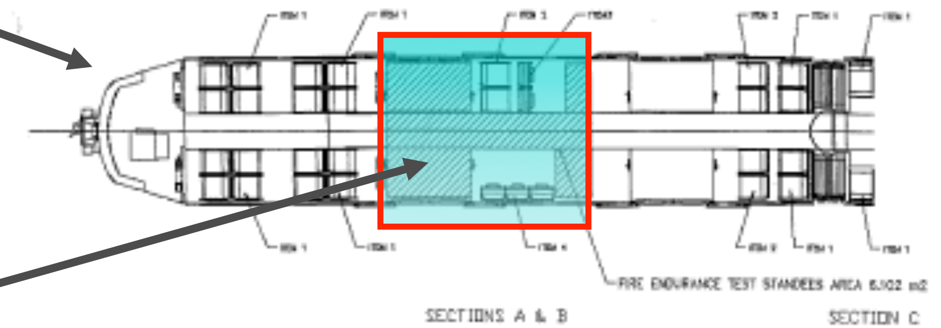


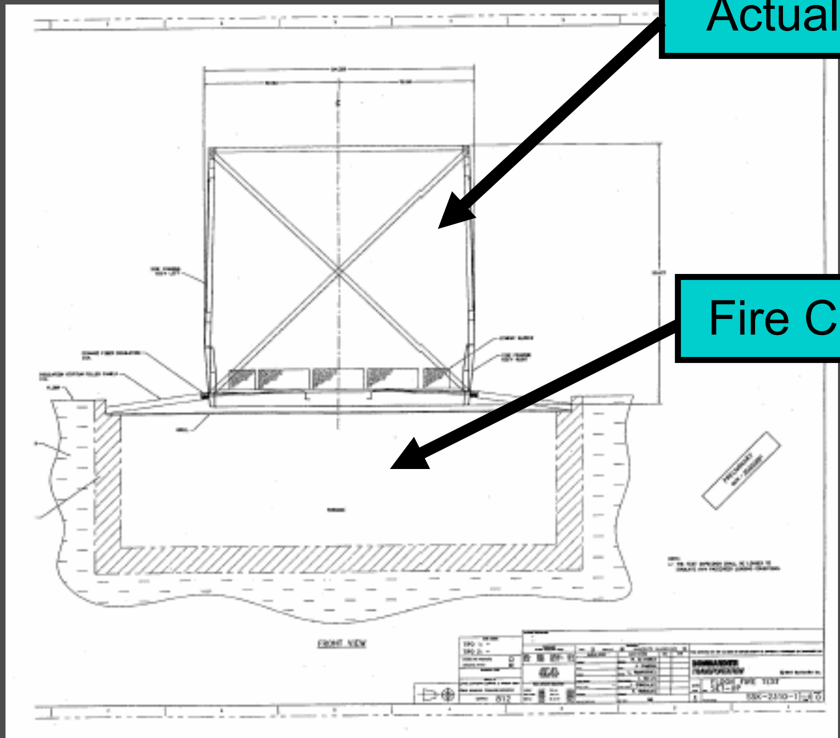
Figure 3

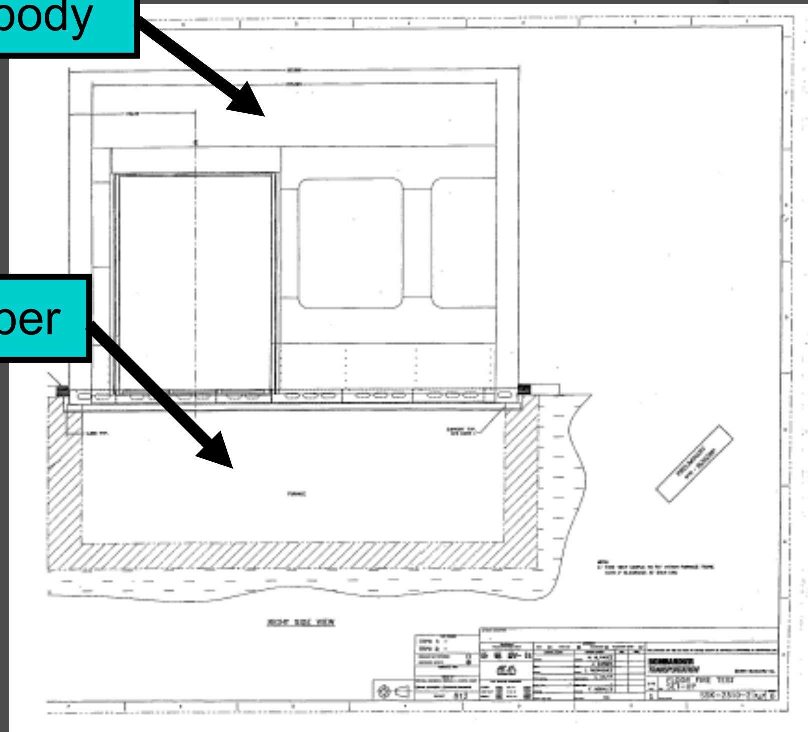
Loading condition	Quantity (units)	Weight (lb)
Standees passenger @ 154 lb/pass (8 pass/m^2 x 6.503 m^2)	48.816	7517.664
Half weight of passenger seated on transverse seats (77 lb/pass)	4	308.000
Half weight of 2 pass. transverse pedestal (original weight 56 lb)	1	28.000
Half weight of 2 pass. transverse flip-up (original weight 80 lb)	1	40.000
3 pass. longitudinal flip-up (original weight 110 lb)	1	0.000
Total load to be applied (lb)		7893.664
Total pressure to be applied over the specimen unexposed area (psi)		0.566

ASTM E-119 Fire Endurance Test: Bombardier Hiawatha Floor Test (Minneapolis, MN)

Actual Carbody

Fire Chamber

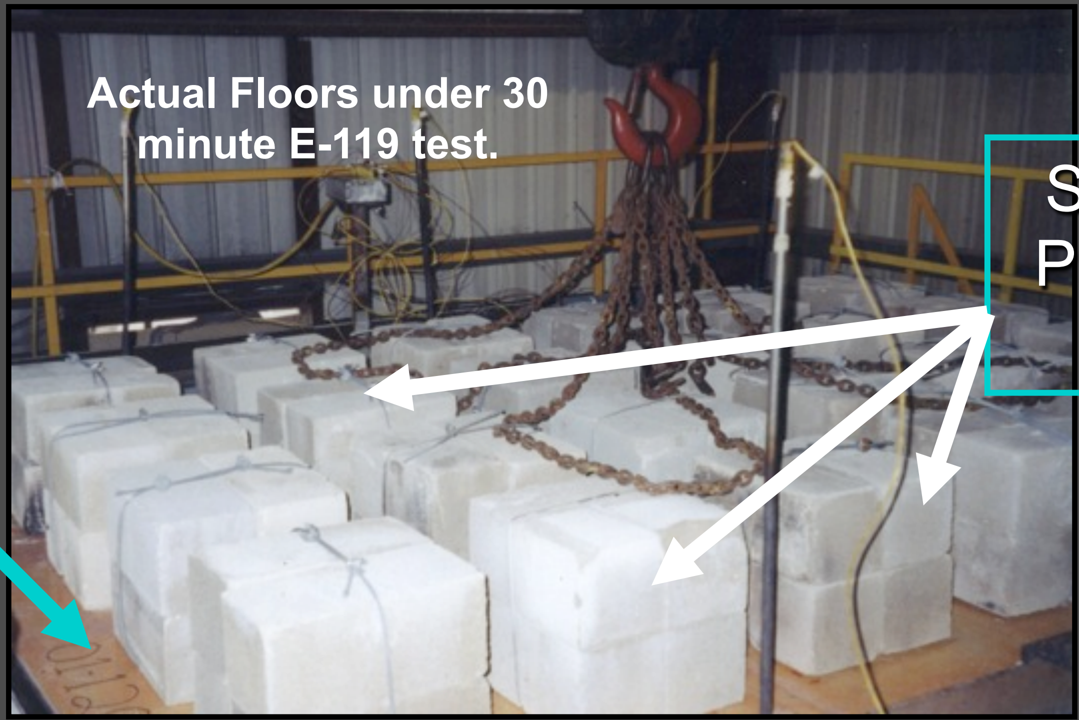




End View: Test Facility

Side View: Test Facility

Tested Fire Safety Compliance:

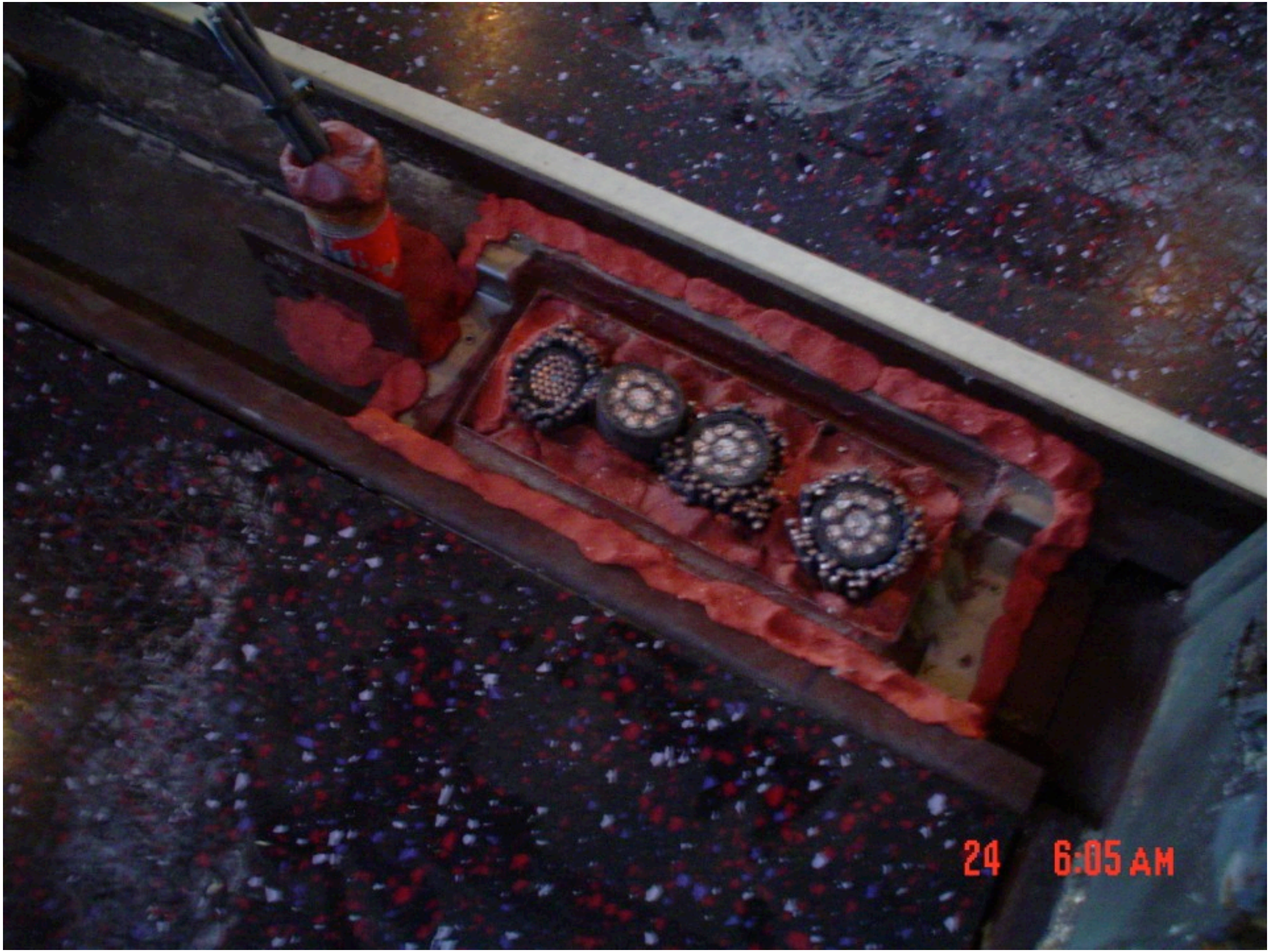


Phenolic Composite Floors Offer Documented Flame, Smoke, and Toxicity Compliance.
ASTM E-119, ASTM E-162, E-662, BSS 7239, SMP 800C, EN 45545 and BS 6853 Class 1a.

Southwest Research NFPA 130/ASTM E-119 Floor Fire Test Cell

(SAN ANTONIO, TEXAS)


NO STEP
24 6:00 AM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