Research

15th ANNUAL WESTFORD SYMPOSIUM ON BUILDING SCIENCE 1

What My Mother Didn't Tell Me About…..

NAILS

15th ANNUAL WESTFORD SYMPOSIUM ON BUILDING SCIENCE 2

CUREE

Consortium of Universities for Research in Earthquake Engineering

The CUREE-Caltech Woodframe Project is funded by the Federal Emergency Management Agency (FEMA) through a Hazard Mitigation Grant Program award administered by the California Governor's Office of Emergency Services (OES and is supported by non-Federal sources from industry, academia, and state and local government. California Institute of Technology (Caltech) is the prime contractor to OES. The Consortium of Universities for Research in Earthquake Engineering (CUREE) organizes and carries out under subcontract to Caltech the tasks involving other universities, practicing engineers, and industry.

PREFACE

Woodframe construction represents one of society's largest investments in built environment, and the common woodframe house is usually an individual's largest single asset. In California, **99%** of all residences are of wood frame construction, and even considering occupancies other than residential, such as commercial and industrial uses, **96%** of all building in Los Angeles County are built of wood. In other regions of the country, woodframe construction is still extremely prevalent, constituting for example, **89%** of all building in Memphis, Tennessee and **87%** in Wichita, Kansas with "the general range of fraction of wood structures to total structures…between **80%** and **90%** in all regions of the US…

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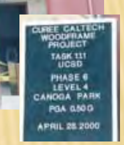


TWO-STORY HOUSE ON SHAKE TABLE AT UCSD WITH SEISMIC MONITORS

15th ANNUAL WESTFORD SYMPOSIUM ON BUILDING SCIENCE 4

WEIGHTS TO SIMULATE FURNITURE AND OCCUPANTS

MONITORING DEVICES ON HOLDOWN AND SILL CONNECTIONS

STRUCTURE WAS PURPOSELY DESIGNED AND CONSTRUCTED WITH BOX NAILS

INSTITUTE FOR BUSINESS AND HOME SAFETY – 2000 INVITATIONAL WORKSHOP

Co-sponsored by American Society of Civil Engineers

Reston, Virginia

SOLUTIONS TO THE TEN MOST WANTED PROBLEMS IN NATURAL HAZARD MITIGATION FACED BY INSURERS

EARTHQUAKES, FLOODS, HIGH WINDS, HURRICANES AND TORNADOS

***90%* OF THE BUILDING IN THE UNITED STATES ARE WOOD-FRAMED STRUCTURES**

- HOMES, APARTMENTS, CONDOMINIUMS
- OFFICES
- COMMERCIAL, INSTITUTIONAL AND INDUSTRIAL
- SCHOOLS. COLLEGES AND UNIVERSITIES

THE REMAINING 10% OF THE BUILDINGS ARE CONSGTRUCTED OF

- CONCRETE
- MASONRY – BRICKS AND CONCRETE BLOCKS
- NATURAL MATERIALS – MUD AND STRAW
- STEEL-FRAMED AND METAL-CLAD (WITH CURTAIN WALL SYSTEMS)

"What My Mother Didn't Tell Me About…..Nails" – August 1992

In September, 1992, before the 1994Northridge Earthquake, this "Nails" article was presented to Messrs. Arthur Devine, Chief, Building Bureau; Robert Harder, Chief of Structural Plan Check; and Russell Lane, Chief Inspector, of the City of Los Angeles Department of Building and Safety, and I expressed my concerns for the nailing deficiencies we had been discovering in wood frame construction projects in Southern California.

When **185** major wood framed structures were checked by the Building Department **engineers**, not inspectors, NONE of the structure conformed structurally to the **Los Angeles Building Department approved construction drawings.**

On October 15, 1992, after the extensive use of ordinary box and sinker nails for **common nails** was verified in the wood frame construction under the Los Angeles Building Department's jurisdiction, Mr. Harder issued an Inter-Departmental Correspondence requiring designers to:

1. ***Use box nail values of Table 25-G of the Uniform Building Code for designed connections.***
2. ***Reduce the common or galvanized box nail size shear design values in Table 25-J-1, 25-J-2, 25-K-1 and 25-K-22 of the Uniform Building Code by twenty (20) percent.***
3. ***Use of common or galvanized box nail design values will be accepted and permitted only when a registered deputy inspector is provided for the project to verify the nailing work.***

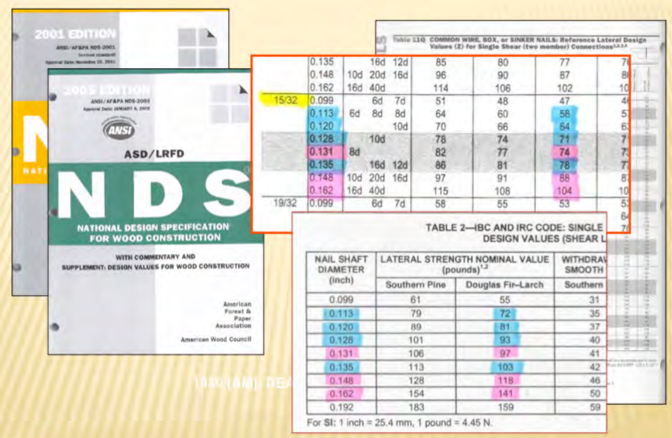
The current International Building Code and the California Building Code both require structural observations and verification of structural elements by the civil/structural engineer or architect of record.

CUREE - Common Nails versus Box Nails Test Results:

CUREE -Caltech Woodframe project (**C**onsortium of **U**niversities for **R**esearch in **E**arthquake **E**ngineering) was a program funded by FEMA, and administered by Cal Tech, to determine how woodframe structures could be voluntarily structurally upgraded to "develop reliable and economical methods of improving woodframe building performance in earthquakes.

In the various shear capacity tests by various university and privately-sponsored groups, the following were the results of the strength differences between the larger diameter common nails and the smaller diameter box nails. (CUREE Publication No. W-80b, D.4.5 Common Versus Gun-Driven Box Sheathing Nails)

1. ***Finding:*** Based on the available information, the life-safety performance of shear walls with sheathing fastening using **gun-driven box nails** can be considered ***EQUIVALENT (7% - 8%) percentage*** *[emphasis added by author] to the performance of common nails of equal penny-weight. This applies to box gun-nails conforming to the nail length and same diameter specifications of ASTM F1667. Shorter length gun-nails have not been investigated.*
2. ***Finding:*** *Based on available information the effective stiffness at design loads of shear walls with* ***gun-driven box nails*** *may be on the order of* ***TWENTY PERCENT LOWER*** *[emphasis added by author] than common nail walls, when considering wood structural panel walls without finishes. For a damage limitation objective, this would be anticipated to result in reduced performance.*



	0.135		16d	12d	85	80	77
	0.148	10d	20d	16d	96	90	87
	0.162	16d	40d		114	106	102
15/32	0.099		6d	7d	51	48	47
	0.113	6d	8d	8d	64	60	58
	0.120			10d	70	66	64
	0.128		10d		78	74	71
	0.131	8d			82	77	74
	0.135		16d	12d	86	81	78
	0.148	10d	20d	16d	97	91	88
	0.162	16d	40d		115	108	104
19/32	0.099		6d	7d	58	55	53

TABLE 2—IBC AND IRC CODE: SINGLE ... DESIGN VALUES (SHEAR L...

NAIL SHAFT DIAMETER (inch)	LATERAL STRENGTH NOMINAL VALUE (pounds)[1,2]		WITHDRAW... SMOOTH
	Southern Pine	Douglas Fir–Larch	Southern
0.099	61	55	31
0.113	79	72	35
0.120	89	81	37
0.128	101	93	40
0.131	106	97	41
0.135	113	103	42
0.148	128	118	46
0.162	154	141	50
0.192	183	159	59

For SI: 1 inch = 25.4 mm, 1 pound = 4.45 N.

8d common nails downsized to 8d box nails: 72/97 = 0.742
Over-spacing o f 8d common nails from 4" oc to 6" oc = 280/430 = 0.651
0.742 x 0.651 = 0.483 or a reduction of 1.00 - 0483 = **51.7% reduction**

END

Shear Transfer Comparison Between

PLYWOOD AND ORIENTED STRAND BOARD

By **Robert M. Powell**, PE
Powell, Mika / Burkett & Wong

January 27,1997

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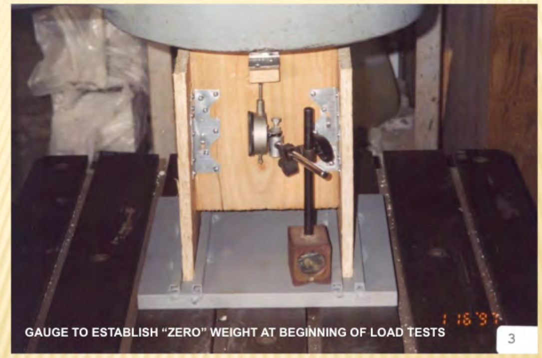

GAUGE TO ESTABLISH "ZERO" WEIGHT AT BEGINNING OF LOAD TESTS

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SCREWS IN OSB SURFACE WERE TORN OUT OF THE MATERIAL

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SCREWS IN PLYWOOD SURFACE REMAINED, BUT THE A35 DEFORMED AT THE SLIT IN THE CONNECTOR

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TESTING PROTOCOL

1. Oriented strand board and plywood were both tested in the dry-state, as purchased.
2. Oriented strand board's strength during dry-state testing was slightly higher in shear than plywood.
3. The A-35 in the oriented strand board failed when the **screws pulled out of the oriented strand board surface.**
4. The A-35 in the plywood **buckled at the slit in the metal connector**, but the **screws remained in the plywood surface.**
5. After both the oriented strand board and the plywood were put through wet and dried cycles, both were tested for shear strength in the same manner as before.
6. Again, the A-35 in the oriented strand board failed when the **screws pulled out of the oriented strand board** surface, at the **average load of 4800 pounds.**
7. In the same manner as before, the A-35 in the plywood buckled at the slit in the metal connector, but the **screws remained into the plywood surface, at the average load of 6400 pounds.**
8. Base on the shear transfer tests, the **shear strength of plywood is 25% greater than oriented strand board**, after the wet and dried cycles.

END

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Tile Roof Underlayment Fire Tests

September 11, 1997

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SBS MINERAL-SURFACED CAP SHEET AND NO. 30 UNDERLAYMENT FELT

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PREPARATION OF TEST ROOFS WITH NO. 30 UNDERLAYMENT FELT AND SBS MINERAL-SURFACED CAP SHEET

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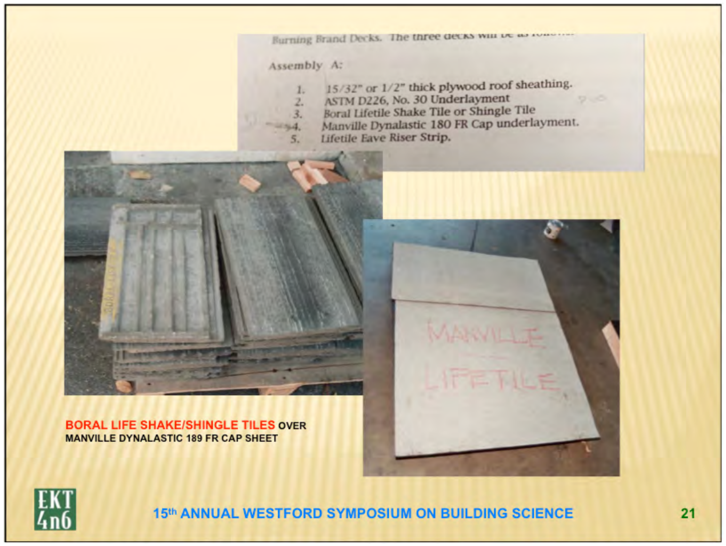
Burning Brand Decks.
Assembly A:
1. 15/32" or 1/2" thick plywood roof sheathing.
2. ASTM D226, No. 30 Underlayment
3. Boral Lifetile Shake Tile or Shingle Tile
4. Manville Dynalastic 180 FR Cap underlayment.
5. Lifetile Eave Riser Strip.
MANVILLE
LIFETILE
BORAL LIFE SHAKE/SHINGLE TILES OVER MANVILLE DYNALASTIC 189 FR CAP SHEET
EKT 4n6
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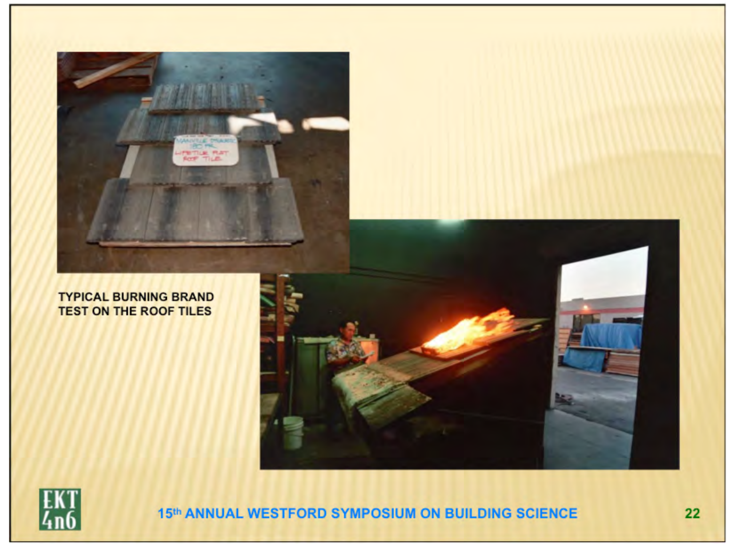
TYPICAL BURNING BRAND TEST ON THE ROOF TILES
EKT 4n6
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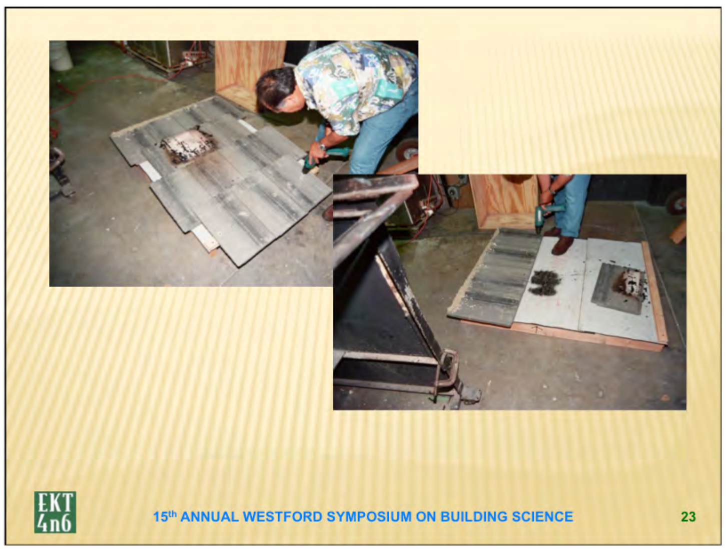
EKT 4n6
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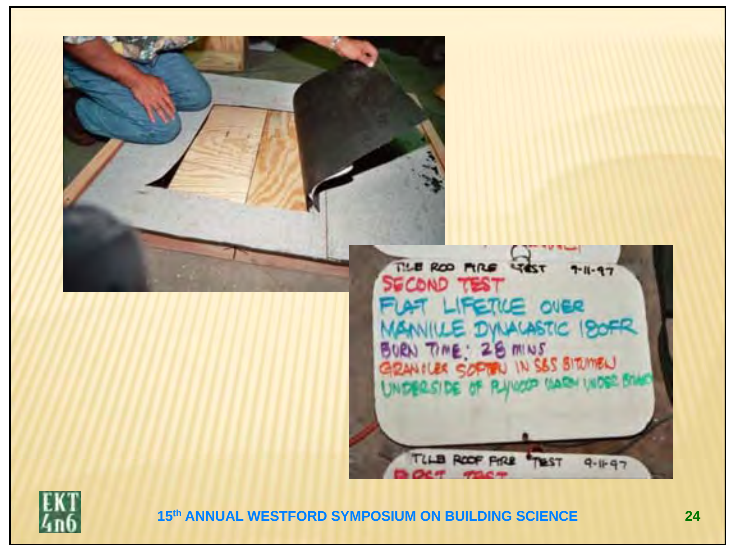
SECOND TEST
BURN TIME: 28 MINS
TILE ROOF FIRE TEST 9-11-97
EKT 4n6
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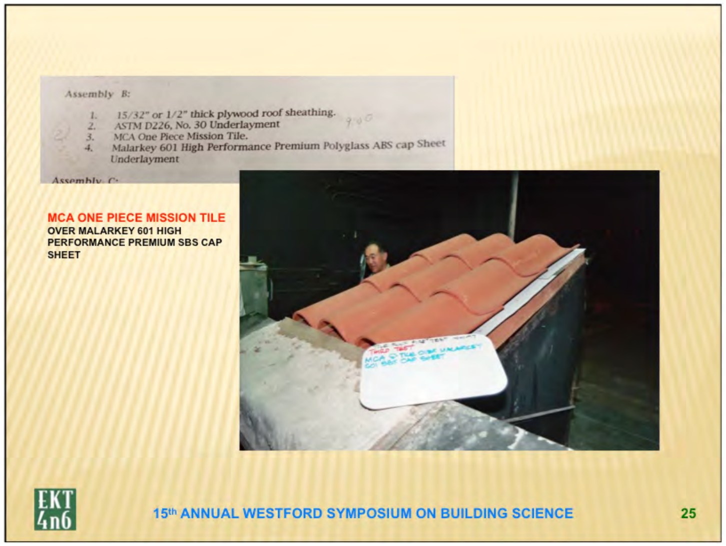
Assembly B:
1. 15/32" or 1/2" thick plywood roof sheathing.
2. ASTM D226, No. 30 Underlayment
3. MCA One Piece Mission Tile.
4. Malarkey 601 High Performance Premium Polyglass ABS cap Sheet Underlayment
MCA ONE PIECE MISSION TILE
OVER MALARKEY 601 HIGH PERFORMANCE PREMIUM SBS CAP SHEET
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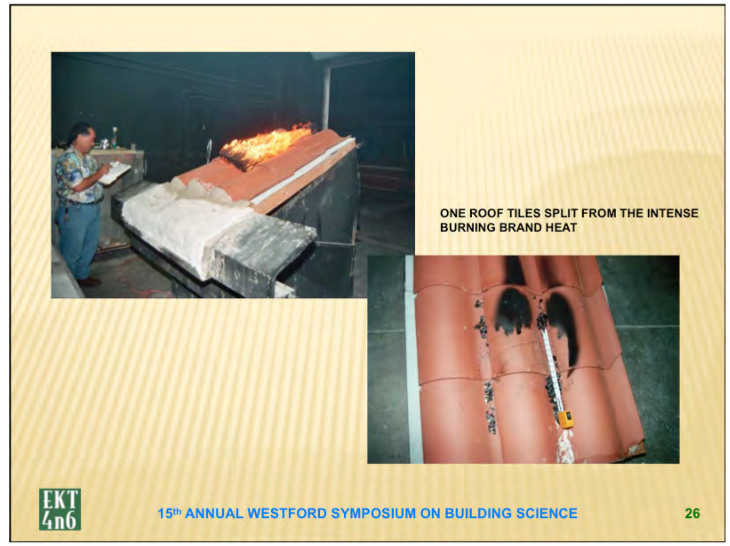
ONE ROOF TILES SPLIT FROM THE INTENSE BURNING BRAND HEAT
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TILE ROOF FIRE TEST 9-11-97
THIRD TEST
MCA S-TILE OVER MALARKEY
601 SBS CAP SHEET
BURN TIME: 24 mins.
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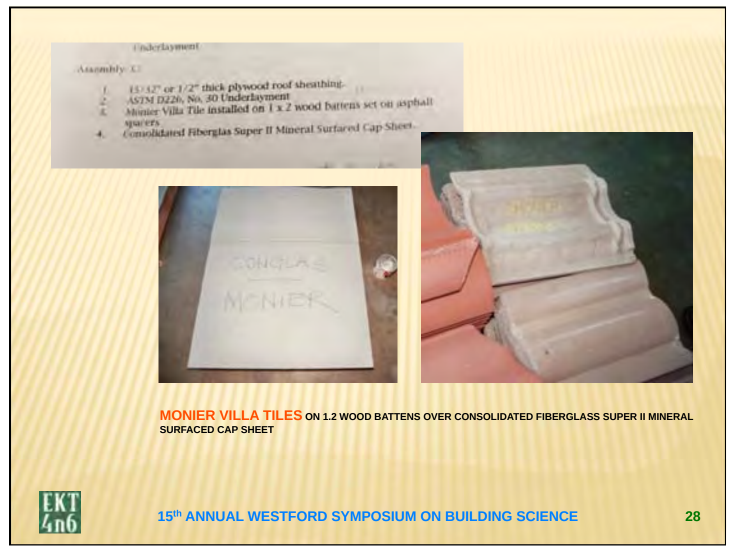
Assembly C:
1. 15/32" or 1/2" thick plywood roof sheathing.
2. ASTM D226, No. 30 Underlayment
3. Monier Villa Tile installed on 1 x 2 wood battens set on asphalt spacers
4. Consolidated Fiberglas Super II Mineral Surfaced Cap Sheet.
MONIER VILLA TILES ON 1.2 WOOD BATTENS OVER CONSOLIDATED FIBERGLASS SUPER II MINERAL SURFACED CAP SHEET
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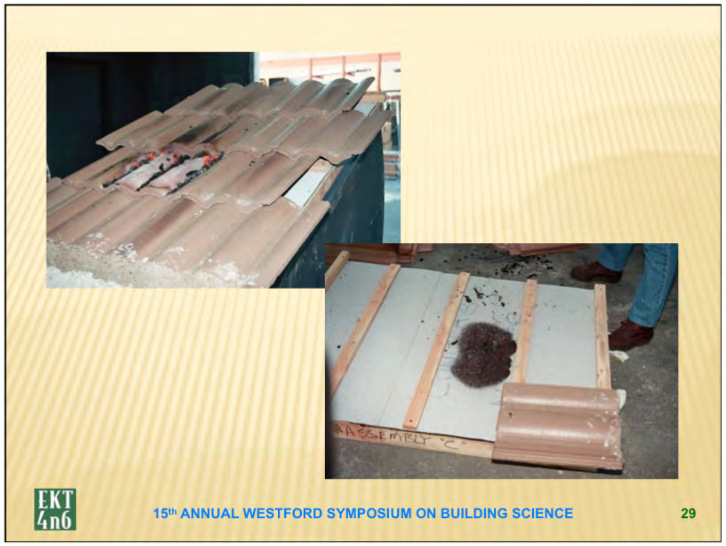
ASSEMBLY "C"
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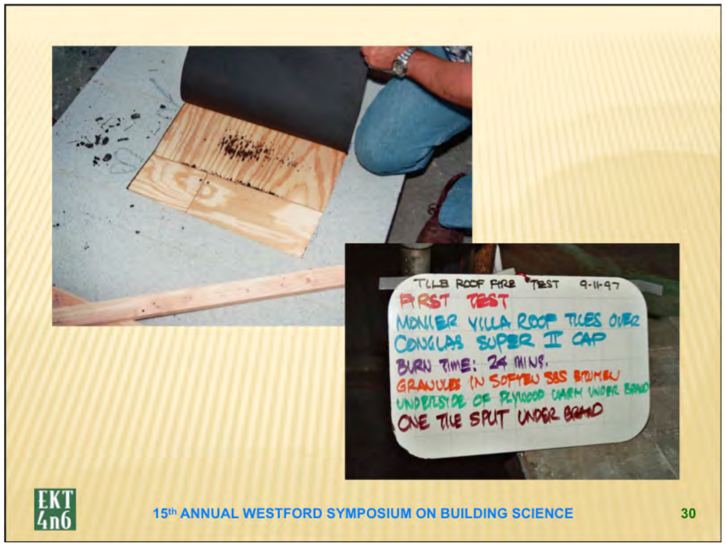
TILE ROOF FIRE TEST 9-11-97
FIRST TEST
MONIER VILLA ROOF TILES OVER
SUPER II CAP
BURN TIME: 24 MINS.
ONE TILE SPLIT UNDER BRAND
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ROOF TILE FIRE TEST 9-13-97
INTERMITTENT FIRE TEST
TEST ON 20 MINS., OFF 2 MINS FOR
1-HOUR
STARTED: 8:57 AM
INTERMINTENT FIRE TESTING
MCA S-TILE OVER MARLAKEY
MINERAL-SURFACED SBS CAP SHEET
15th ANNUAL WESTFORD SYMPOSIUM ON BUILDING SCIENCE
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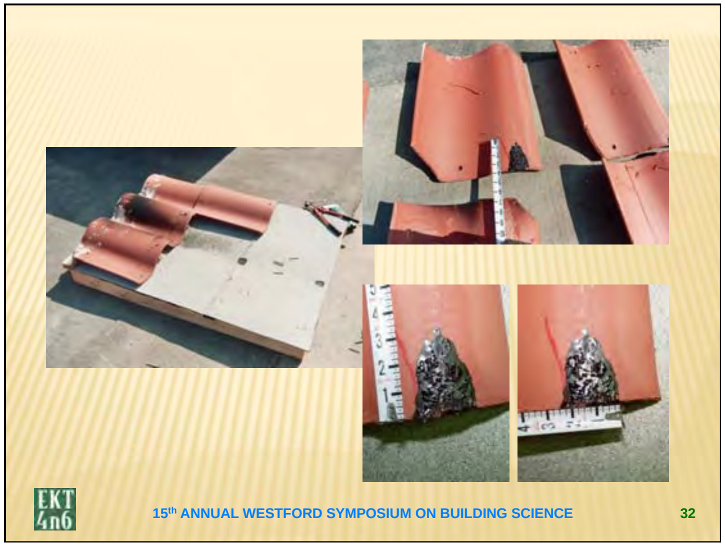
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END

FIRESTOPPING

In Wood Frame Double Party Wall Construction

Photographs by Michael Clements, AIA, Clements Construction Consultants

2X WOOD BLOCKING WAS BURNED OFF IN 40 MINUTES.

TEST HALTED AT 1 HOUR, 45 MINUTES, BECAUSE THE TEST STAND STARTED TO BURN

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END

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End of Research

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