FLAME RETARDANCY

Session IV

INDUSTRIAL APPLICATION AND CONSUMER FOCUS

IV-A CONE CALORIMETER TESTS OF WOOD-BASED DECKING MATERIALS

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ABSTRACT

New technologies in building materials have resulted in the use of a wide variety of materials in decks. As part of our effort to address fire concerns in the wildland–urban interface, the Forest Products Laboratory has been examining the fire performance of decking products. In addition to preservative-treated wood, decking products include wood–plastic composites and imported wood species. Requirements for wood–plastic composites are often based on expectation for untreated wood. Claims for imported wood species have included Class A flame spread ratings. This paper discusses results of cone calorimeter tests conducted on a variety of wood-based decking materials.

INTRODUCTION

This paper is an initial compilation of Forest Products Laboratory (FPL) cone calorimeter test data on wood-based decking materials. The heat released due to combustion is measured in the cone calorimeter. Included are tests on preservative-treated wood, domestic and imported wood species with natural durability, and wood–plastic composites (WPCs). As part of our effort to improve the survivability of homes in the wildland–urban interface (WUI), cone calorimeter testing of exterior building products is a continuing project at FPL.

Increased severity of wildfires coupled with increased urbanization of rural areas has magnified the problems of wildfires in the WUI. In the conterminous United States, the WUI represents 9% of the land area and includes 39% of all houses (Radeloff et al. 2005). The U.S. Forest Service, other federal agencies, state agencies, and local governments have intensified their efforts to address the problem by a wide range of activities—-from improving the health of our forests and reducing fuel loads in the wildlands to increased educational and regulatory efforts to improve the fire safety of homes and other structures in the WUI. Efforts to improve the survivability of homes include establishing and maintaining a defensible space around the home and improving the resistance of the homes to fire exposures from the exterior. As a result, the fire performance of exterior building products is being given increased attention. Shook and Eastin (2001) found that nearly 60% of new spec homes and 68% of new custom homes were built with decks between November 1996 and October 1998. Smith (2001) described the market for decking and railing materials as being dominated by pressure-treated lumber (80%) and having a value of approximately $3.2 billion dollars. The 2002 decision by the wood-treating industry to withdraw lumber treated with chromated copper arsenate (CCA) from the residential decking market required the treating industry to introduce new treated lumber products for a market long dominated by CCA-treated lumber (Lebow 2004). The decking market has become the largest and fastest growing market for WPCs (Clemons 2002).

FIRE PERFORMANCE OF DECKING MATERIALS

Shook and Eastin (2001) identified seven materials as being used on a consistent and measurable basis: pressure-treated lumber, western redcedar, redwood, untreated lumber, WPCs, plastic lumber, and concrete. Smith and Wolcott (2006) estimated that the $3.9 billion 2005 U.S. residential and industrial deckboard and railing market was 64% pressure-treated wood, 18% WPCs, 6% redwood, 5% imported wood species, 3% cedar, and 2% plastics. Limited information on the fie performance of these materials is available in the literature.

The ASTM E 84 flame spread test is the most common test used to regulate the flammability of building materials in the United States. Most wood species, including southern pine, have a Class C flame spread index (FSI) of 200 or less (AF&PA 2002). In addition to having natural durability, redwood and western redcedar have a Class B FSI of 75 or less when tested in accordance with ASTM E 84 (AF&PA 2002). Advertisements for ipe and some other very high-density imported species make claims of Class A FSI of 25 or less. Class B results for some imported hardwood species are cited by White (2000). All reported FSI values for domestic hardwood species (nominal 1-in.-thick lumber) are for Class C. No information on fie performance of preservative-treated wood was found on industry web sites. Cone calorimeter data on wood products can be found in various FPL publications (White and Dietenberger 2004, White 2000, Tran 1992).

Research on the fire performance of WPCs has included the development of alternative fire test methods. Washington State University/U.S. Navy research on the fire performance of WPCs included fire propagation tests involving the application of ASTM E 108 burning brands and ASTM D 1929 ignition tests (Malvar et al. 2001). Burning brands fire propagation testing is intended to address scenarios such as burning coals from a charcoal grill or embers from a wildfire. Their research program also included ASTM E 662, ASTM E 1354, and modified ASTM E 119 testing of WPCs (Sorathia et al. 2002). In their development of new fire test protocols for the WUI, considerable fire testing of WPCs was done by the former University of California Forest Products Laboratory before its closure (nature.berkeley.edu/~fbeall/ firemit.html, confirmed 3/21/2007). In an earlier FPL study, heat release testing on WPCs was done with an Ohio State University apparatus (ASTM E 906) (Stark et al. 1997). At the 2006 BCC conference, Shen (2006) presented results on the use of borates and talc as fire retardants in WPCs. Company literature and model building code evaluation reports for WPCs include statements that the ASTM E 84 FSI is 200 or less. When the ASTM E 84 smoke-developed index (SDI) is mentioned, a SDI in excess of 450 is sometimes indicated. Both the FSI of 200 and SDI of 450 reflect current building code requirements.

EXPERIMENTAL

MATERIALS

Three groups of wood-based materials are included in this compilation of cone calorimeter data (Table 1):

A. Untreated and preservative-treated southern pine lumber
B. Domestic and imported wood species with a degree of natural durability
C. Commercial and laboratory samples of WPC

Group A southern pine (*Pinus* sp.) lumber specimens (A1 to A8, Table 1) included 19-mm- and 37-mm- thick samples that had been treated at FPL with either CCA-Type C, alkaline copper quat–Type D (ACQ-D), or ammoniacal copper citrate (CC). The retention levels were approximately 8 kg/m^3 (0.5 lb/ft^3). ACQ–Type D is an amine copper formulation (Lebow 2004). CC has only limited commercial availability (Lebow 2004). Specimens A9 and A10 were commercially treated CCA and ACQ lumber obtained from a local supplier.

TABLE 1

HEAT RELEASED IN CONE CALORIMETER TESTS[A]

Material	Density[b] (kg/m³)	Frame/ grid[c]	PHRR (kW/m²)	tPHRR (s)	HRR60 (kW/m²)	HRR300 (kW/m²)	THR (MJ/m²)	*N*
Preservative-treated lumber								
A1 Untreated s. pine, 37 mm	510	y/n	172	51	112	107	214	3
A2 Untreated s. pine, 19 mm	508	y/n	165	50	110	107	116	3
A3 Treated s. pine, CCA-C, 37 mm	514	y/n	185	53	117	116	190	3
A4 Treated s. pine, CCA-C, 19 mm	496	y/n	174	69	115	118	108	3
A5 Treated s. pine, ACQ-D, 38 mm	504	y/n	185	49	118	109	199	3
A6 Treated s. pine, ACQ-=D, 19 mm	514	y/n	186	55	115	115	114	3
A7 Treated s. pine, CC, 37 mm	530	y/n	183	56	119	115	214	3
A8 Treated s. pine, CC, 19 mm	517	y/n	175	55	115	115	111	3
A9 Treated s. pine, CCA, 16 mm	588	n/n	187	60	155	137	97	3
A10 Treated s. pine, ACQ, 24 mm	591	n/n	244	34	192	142	157	1
Durable wood species								
B1 Eastern redcedar, 25 mm	553	n/n	176	62	92	85	125	3
B2 Northern white cedar, 24 mm	479	n/n	182	29	143	100	122	1
B3 Redwood, 19 mm	432	n/n	228	44	119	95	92	3
B4 Black walnut, 19 mm	646	n/n	216	60	115	119	109	3
B5 Black cherry, 20 mm	624	n/n	187	57	116	105	106	3
B6 White oak, 19 mm	745	n/n	220	67	137	122	130	3
B7 Bubinga, 20 mm	999	n/n	207	98	108	114	161	3
B8 Imbuia, 19 mm	676	n/n	221	60	135	116	128	3
B9 Ipe, 19 mm	967	y/n	204	60	168	142	214	6
B9a Ipe, 24 mm	1,139	y/n	228	62	190	152	329	1
B10 Lacewood, 19 mm	598	n/n	188	52	116	99	95	3
B11 Padauk, 26 mm	750	n/n	225	73	119	122	193	3
B12 Purpleheart, 20 mm	934	n/n	182	78	100	98	138	3
B13 Teak, 22 mm	601	n/n	249	63	135	131	144	3
Wood-plastic composites								
C1 WPC 1, 25 mm	1.031	n/n	518	64	384	329	574[d]	1
C2 WPC 2, 31 mm	990	n/n	487	58	362	291	502[d]	1
C3 WPC 3, 24 mm	1,109	n/n	374	57	286	204	403[d]	1
C4 WPC 4, 10 mm	1,129	n/n	440	59	318	264	256	1
C5 FfPL 1, 56% WF/HDPE, 32 mm	1,049	n/n	465	74	337	282	463[d]	1
C6 FPL 2, 56% WF/PP, 32 mm	1.048	n/n	519	59	393	311	526[d]	1
C7 FPL 3, HDPE only, 14 mm	965	n/n	1790	708	270	601	609	1
C7a FPL 3, HDPE only, 14 mm[e]	965	n/n	961[e]	342[e]	291	—[e]	171[e]	2
C8 FPL 4, 60% WF/HDPE, 13 mm	1,042	n/n	437	68	314	260	317	3
C9 FPL 5, 50% WF/HDPE, 14 mm	1,016	n/n	505	72	348	325	372	3

[a]Results include initial peak heat release rate (PHRR), time for PHRR (tPHRR), heat release rate (HRR) averaged for 60 s after the observation of sustained ignition (HRR60), the corresponding average HRR for 300 s (HRR300), and total heat released (THR). Results listed are the averages for the *N* replicates.
[b]Density calculated from mass as tested and dimensions of test specimen.
[c]Specimen tested with retainer frame (yes/no) and grid (yes/no) on the specimen holder (ASTM E 1354).
[d]Test terminated at 3600 s, prior to cessation of flaming or 150 g/m² mass loss criteria.
[e]Test terminated early to protect equipment, heat release rate still increasing.

Group B of naturally durable species (B1 to B13, Table 1) included three domestic softwoods (eastern redcedar (*Juniperus virginiana*), northern white cedar (*Thuja occidentalis*), and redwood (*Sequoia sempervirens*)); three domestic hardwoods (black walnut (*Juglans nigra*), black cherry (*Prunus serotina*), and white oak (*Quercus* sp.)); and seven imported species (bubinga (*Guibourtia tessmannii*), imbuia (*Phoebe porosa*), ipe (*Tabebuia* sp.), lacewood (*Grevillea robusta*), padauk (*Pterocarpus soyauxii*), purpleheart (*Peltogyne* sp.), and teak (*Tectona grandis*)). The criterion for inclusion of a species was whether it was considered to have natural durability to biological degradation (FPL 1999, Chudnoff 1984).

Group C of WPCs (C1 to C9, Table 1) included four commercial WPCs that were purchased from a local supplier (C1 to C4, identified as WPC 1 to 4). From information that was available, WPC 1 was made from wood flour (>50%) and high-density polyethylene (HDPE); WPC 2 was made from recycled wood fiber (~50%) and low-density polyethylene (LDPE); WPC 3 made from wood flour (>50%) and HDPE; and WPC 4 was made from wood flour (~50%) and HDPE. However, this information was not specific to the specimens obtained from the local supplier nor was it verified. It was not known if the composites contained additives such as lubricants or fire retardants. WPC 1, 2, and 3 were solid decking profiles; WPC 4 was a hollow profile. The lower portion of WPC 4, the hollow profile, was cut off to create a 10-mm-thick planar specimen. Specimens C5 and C6 were prepared specifically for the FPL and are designated FPL 1 and FPL 2. Both types of specimens were made from 56% pine wood flour (AWF4020, American Wood Fibers, Schofield, WI). The plastic component was 40% HDPE (Exxon Mobil 6605.70, 5 mfi, Houston, TX) for FPL 1 (C5) and 40% polypropylene (PP, BP Amoco 10-4036, 4.7 mfi, London, UK) for FPL 2 (C6). FPL 1 and FPL 2 also contained 4% lubricant (TPW 113, Struktol, Stow, OH). Specimens C7, C8, and C9 were manufactured at FPL and are designated FPL 3, 4, and 5. Specimen C7 was made solely from HDPE (Certene HPB-0760, 0.7 mfi, Norwalk, CT). Specimens C8 and C9 were also prepared at FPL from pine wood flour (AWF 4020). HDPE (Certene HPB-0760), and lubricant (TPW 113). The formulations were 60% wood flour, 35% HDPE, and 5% lubricant for C8 and 50% wood flour, 45% HDPE, and 5% lubricant for C9. Specimens C7 to C9 were control specimens for an FPL/University of Wisconsin–Madison study investigating fire-retardant treatments for WPCs. The thickness and density of the specimens are listed in Table 1.

FIGURE 1

HRR CURVES FOR WOOD SAMPLES INCLUDING UNTREATED SOUTHERN PINE (A2), CCA-TREATED PINE (A4), ACQ-TREATED PINE (A6), AND IPE (B9)

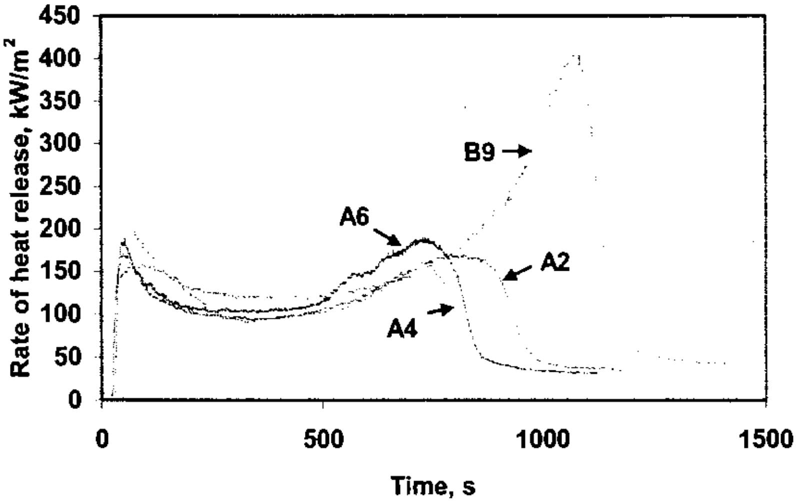
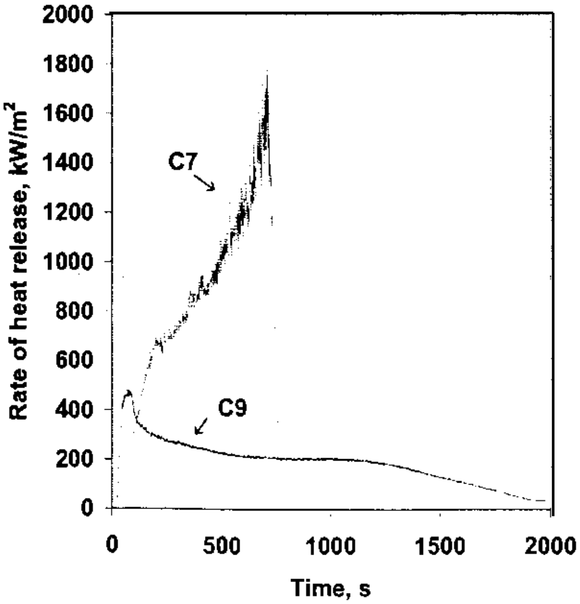


FIGURE 2

HRR CURVES FOR A PURE HDPE SAMPLE (C7) AND A WPC SAMPLE (C9)



CONE CALORIMETER TESTS

Specimens were tested in the cone calorimeter at FPL following the methodology specified in ASTM E 1354 (ASTM International 2004). The 100- by 100-mm specimens were wrapped with aluminum foil on the sides and bottom and placed in the specimen holder lined with a ceramic blanket. Specimens were either tested in the sample holder with the retainer frame but no grid or without the retainer frame (Table 1). The orientation of the test specimen was horizontal and the constant external heat flux was 50 kW/m^2. The spark igniter was used. In most cases, three replicates were tested (Table 1). For some materials, only one replicate has been completed at this time. The cone calorimeter uses the oxygen consumption methodology to obtain the heat released due to combustion. In addition to heat release, measurements are made of mass loss, obscuration of a laser beam in the ducts, and time for sustained ignition of the specimen.

RESULTS

HEAT RELEASED (TABLE 1)

Heat release rate (HRR) curves from cone calorimeter tests of untreated and preservative-treated wood specimens (A1–A10, B1–B13) were typical for wood products: an initial peak is followed by decreasing rates until rates increase again for a second peak HRR (Figure 1). Averages for the initial peak heat release rate (PHRR) for these 23 wood products ranged from 165 kW/m^2 (A2, untreated pine) to 249 kW/m^2 (B13, teak) (Table 1). In contrast, HRR for the HDPE (C7) samples increased continuously until the sample was consumed (Figure 2). The initial test of the HDPE samples was continued until the sample was nearly consumed (3% initial mass left). The PHRR was 1,790 kW/m^2. To protect the equipment, the two additional replicates were terminated when the PHRR exceeded 900 kW/m^2. As for the wood samples, HRR curves for the WPCs increased to an initial PHRR early in the tests and then steadily decreased with time (Figure 2). A second peak was not observed with the WPCs. Average PHRR for the WPCs (C1-C6, C8, C9) ranged from 374 kW/m^2 (C4, WPC 4) to 519 kW/m^2 (C6, FPL 2 made from PP). Initial sample mass and dimensions of the test specimen were used to calculate density as tested (Table II). For WPCs, the PHRR decreased with density (R^2 = 0.37).

Besides PHRR and time for the initial PHRR (tPHRR, Table I), other results tabulated from the HRR curves included average HRR for 60 s (HRR60) and 300 s (HRR300) after observation of sustained ignition and total heat released (THR) (Table I). Higher HRR was observed for the commercial ACQ sample (A10) but still withn the likely variability for untreated southern pine samples. Tests of the thicker WPCs (C1, C2, C3, C5, C6) were terminated at 3,600 s even though heat release and mass loss continued. The THRs for these materials are for the amount of material consumed in the 3,600 s rather than the total thickness of the sample. For the wood samples, the regression of THR with initial mass had a R^2 of 0.80.

OTHER CONE CALORIMETER RESULTS (TABLE 2)

Other tabulated results from the cone calorimeter tests included average mass loss rate for the duration of the test (AMLR), average effective heat of combustion (AEHOC), average smoke extinction area (ASEA), time for sustained ignition (TSI), and residual mass fraction (RMF) (Table 2). Averages for AEHOC for the wood samples ranged from 10.1 MJ/kg (B12, purpleheart) to 13.4 MJ/kg (A10, ACQ treated pine). The AEHOC of the wood samples were inversely correlated with the RMF (R^2 = 0.27). The average of the AEHOC for the HDPE samples was 43.7 MJ/kg. The averages for the AEHOC for the WPCs ranged from 21.5 MJ/kg (C5 FPL sample 1-6 made from HDPE) to 30 MJ/kg (C9, FPL sample made with 45% HDPE). The pure HDPE samples took 82 s for sustained ignition (average). Average TSIs for the WPCs were in a narrow range (22.1 to 28.4 s) (Table 2), which was within the range of TSIs for the wood samples. Average TSI for the wood samples ranged from 15 s (A5 and A6, ACQ treated pine) to 57.3 s (B7, bubinga). The TSI for the wood samples increased with sample density (R^2 = 0.66).

PREDICTED ASTM E 84 FSI

The predictive model developed by Dietenberger (Dietenberger and White 2001) was used to obtain estimates for the ASTM E 84 FSI. In the model, results from the cone calorimeter are used to calculate a fire growth acceleration parameter ß (Table II). The acceleration parameter incorporates data for PHRR, THR, and TSI into a single parameter. An acceleration parameter greater than zero indicates a degree of fire growth above that of steady growth. A degree of damping of fire growth after ignition is indicted by negative values. Fire-retardant treatments are used to provide damping of fire growth in combustible materials. We use values for ß to divide the materials into the classes used in building codes to classify materials for surface flammability based on their ASTM E 84 FSI. A ß of 0.184 is used to dlfferentiate between Class C and Class B materials and ß of 0 to differentiate between Class B and Class A. The predicted ASTM E 84 FSIs were calculated from a logarithmic correlation between ß and the ASTM E 84 FSI (Table II). The logarithmic relationship between ß and the FSI used to estimate the FSI is not sensitive to variations in FSI greater than about 75 or less than 25 and does not produce a numerical FSI estimate for high values of ß. Thus, there is no estimate for ß associated with a FSI of 200, the upper limit for Class C.

TABLE 2

Material	AMLR (g/s m²)	AEHOC (MJ/kg)	ASEA (m²/kg)	TSI (s)	RMF (%)	ß	Predicted FSI[b]	Test no.
Preservative-treated lumber								
A1 Untreated s. pine, 37 mm	7.94	12.50	30.8	18.0	20	0.183	75	577
A2 Untreated s. pine, 19 mm	9.57	12.95	72.7	18.8	19	0.172	68	573
A3 Treated s. pine, CCA-C, 37 mm	7.58	11.42	28.7	19.0	23	0.193	80	574
A4 Treated s. pine, CCA-C, 19 mm	10.15	12.29	63.3	17.1	20	0.186	77	570
A5 Treated s. pine, ACQ-D, 38 mm	8.28	11.68	50.0	20.5	15	0.208	93	575
A6 Treated s. pine, ACQ-D, 19 mm	10.83	12.35	57.3	15.2	18	0.216	103	571
A7 Treated s. pine, Cu-Cit, 37 mm	8.54	12.07	26.0	21.2	21	0.190	78	576
A8 Treated s. pine, Cu-Cit, 19 mm	10.60	12.39	62.6	18.3	20	0.187	80	572
A9 Treated s. pine, CCA, 16 mm	11.69	12.51	65.6	27.1	17	0.182	75	236
A10 Treated s. pine, ACQ, 24 mm	9.06	13.36	69.7	21.1	20	0.291	—	1,336
Durable wood species								
B1 Eastern red cedar, 25 mm	6.88	11.77	52.6	25.4	24	0.154	61	283
B2 Northern white cedar, 24 mm	6.66	12.55	28.8	16.1	17	0.196	82	1337
B3 Redwood, 19 mm	7.22	13.30	65.7	17.5	16	0.260	—	267
B4 Black walnut, 19 mm	11.81	10.83	61.2	25.2	19	0.224	126	276
B5 Black cherry, 20 mm	9.55	10.99	12.2	26.1	23	0.173	69	271
B6 White oad, 19 mm	10.41	11.42	19.5	33.0	20	0.219	91[b]	270
B7 Bubinga, 20 mm	10.69	10.53	22.0	57.3	25	0.149	59[b]	282
B8 Imbuia, 19 mm	9.04	12.57	86.2	29.0	22	0.232	85[b]	268
B9 Ipe, 19 mm	14.09	12.92	201.7	33.2	20	0.239	109[b,c]	1,414
B9a Ipe, 224 mm	11.61	13.73	250.6	32.7	24	0.287	—	1,414
B10 Lacewood, 19 mm	8.05	10.89	22.8	19.1	23	0.195	83	269
B11 Padauk, 26 mm	7.99	13.06	92.7	29.9	23	0.247	151[b]	279
B12 Purpleheart, 20 mm	9.55	10.09	8.14	40.1	26	0.151	60	277
B13 Teak, 22 mm	8.40	13.67	229.2	24.9	20	0.286	—	278
Wood-plastic composites								
C1 WPC 1, 25 mm	7.38	26.19	214.3	22.4	15[d]	0.837	—	1,284
C2 WPC 2, 31 mm	6.11	22.58	164.6	22.7	25[d]	0.763	—	1,285
C3 WPC 3, 24 mm	5.08	22.92	91.3	22.1	34[d]	0.569	—	1,335
C4 WPC 4, 10 mm	8.29	29.30	240.0	27.8	26	0.691	—	1,343
C5 FPL 1, 56% WF/HDPE, 32 mm	5.87	21.54	188.0	28.4	36[d]	0.697	—	1,283
C6 FPL 2, 56% WF/PP, 32 mm	5.46	26.26	326.4	22.1	39[d]	0.820	—	1,286
C7 FPL 3, HDPE only, 14 mm	22.73	43.59	409	71.2	3	—	—	1,368
C7a FPL 3, HDPE only, 14 mm[e]	15.64[e]	43.71	445.5	88	70[e]	—		1,368
C8 FPL 4, 60% WF/HDPE, 13 mm	7.52	25.81	250.0	24.9	13	0.689	—	1,371
C9 FPL 5, 50% WF/HDPE, 14 mm	7.80	29.98	330.2	24.4	12	0.818	—	1,373

[a]Results include average mass loss rate (AMLR), average effective heat of combustion rate (AEHOC), average smoke extinction area (ASEA), time for sustained ignition (TSI), residual mass fraction (RMF), fire growth acceleration parameter (ß), and a prediction of the ASTM E 84 flame spread index (FSI). The test number in FPL records is also listed.

[b]FSI estimated using model of Dietenberger. Valuer listed are averages for tests that produced results within bounds of regression used in the model.

[c]See text for discussion of possible sources of error in this prediction.

[d]Tests terminated at 3600 s, prior to total consumption of sample.

[e]Tests terminated early to protect equipment, heat release rate still increasing.

Despite the model insensitivity in the upper range of FSI represented by the materials tested, estimates for FSI were generally consistent with the limited ASTM E 84 experimental data (FPL 1999, AF&PA 2002) for the species tested. Predictions consistent with experimental data for unmatched samples of the same species included 82 predicted for northern white cedar (B2) and 61 predicted for eastern redcedar (B1) compared with 78 experimental for pacific coast yellow cedar and 70—73 experimental for western redcedar; 126 predicted for black walnut (B4) compared with 101 and 130 to 140 experimental; 69 predicted for black cherry (B5) compared with 76 experimental; and 91 predicted for white oak (B6) compared with 77 experimental.

Predictions for FSI not consistent with experimental data include failed prediction for redwood (B3); the 109 prediction for ipe (B9) and the 68 and 75 predictions for untreated southern pine samples (A1 and A2). Predicted FSI for the untreated southern pine samples and similar results for the preservative-treated samples are lower than the 130 to 195 reported for southern yellow pine. However, the predicted 68 and 75 are consistent with experimental data for other species of pine and could be obtained for southern pine samples with low resin content. The high estimates for the ipe and redwood specimens were likely due to using THR to account for heat released after the initial PHRR. The FSI in the literature for redwood is 70. The model assumes the decrease in HRR after the PHRR is exponential. Although PHRR for the redwood was high, the shape of the decay portion of the heat release curve is such that the model assumes higher HRR than is actually occurring. Examination of the heat release curve (Figure 1) for ipe suggests that the THR is inappropriate for ipe due to its very large second peak HRR. A considerable portion of the THR occurs in the second peak and at a time that exceeds the 10-min duration of the standard ASTM E 84 test. Reducing the THR by 50%, the predicted FSI for ipe is reduced to an average value of 44. Comparison of the 50% THR with the THR of the other species suggests the 50% reduction is reasonable to eliminate the impact of the second peak on the model predictions. Tests have also shown that testing cone calorimeter samples with the backing board used in the ASTM E 84 test reduces the second peak (Hagge et al. 2004).

A regression of literature FSI data with literature values for density (White 2000) suggests hardwood species with density as tested of 763 kg/m^3 and 1,057 kg/m^3 have FSIs of 75 and 25, respectively. Using this regression, the estimated FSI for the bubinga, imbuia, ipe, lacewood, padauk, and purpleheart samples were 33, 105, 40, 123, 89, and 48, respectively. The corresponding estimates from the model of Dietenberger were 59, 85, 109, 83, 151, and 60 (Table II). As previously discussed, adjusting the THR resulted in a predicted FSI of 44 for ipe. Of the species tested, ipe is of most interest. Both the 40 and 44 estimated FSI are higher than the Class A rating reported on the internet. However, the reported density range for ipe in the literature suggests that experimental FSI under 25 are consistent with the empirical density model.

CONCLUDING REMARKS

With the increased diversity of products available for construction of decks, data on their fire performance is needed. In this paper, we reported on our compilation of cone calorimeter data for preservative-treated southern pine lumber, naturally durable wood species, and WPCs. Test results for the CCA-, ACQ-, and CC-treated lumber were consistent with untreated southern pine lumber and a Class C FSI rating. The various durable wood species represented a range of densities and included both softwood and hardwood species. As a result, test results were for a wide range of heat release and were consistent with Class B or Class C FSI ratings, depending on the species. Both commercial and laboratory-made WPC samples produced similar results. The addition of wood fiber to the plastic changed the heat release curve from one of increasing heat release rate to one with an early peak followed by decreasing heat release rate. FPL will be continuing to add to its compilation of data on decking materials and other exterior building materials as part of its efforts to address the survivability of homes in wildland fires.

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