TECHNICAL NOTE

Fumigant Treatment of Douglas-Fir Bridge Timbers

Jeffrey J. Morrell
Connie S. Love
Camille Freitag

Abstract

The residual protective effect of sodium *n*-methyldithiocarbamate (NaMDC) fumigant was investigated in Douglas-fir timbers in a bridge in western Oregon using fungal colonization and levels of methylisothiocyanate (MITC; the primary fungitoxic breakdown product of NaMDC) as the measures of protection. MITC levels were above the presumed protective threshold 7 years after treatment and remained above that level in four of five timbers 12 years after treatment. These results differ from those found in round timbers and suggest that the combination of a protective-treated shell and the sawn surface resulted in a more prolonged protective period against renewed fungal attack. These results illustrate the benefits of NaMDC treatment on bridge timbers.

Wood is an excellent renewable structural material that provides long-term performance under adverse environmental conditions when it is treated with preservatives. Over time, deep checks can develop in the treated wood, and these checks can expose nontreated wood to possible fungal or insect attack and, eventually, internal decay. The overall result will be weakened wood with a shorter service life.

One method for limiting the development of internal decay is remedial treatment with either water-diffusible chemicals or volatile fumigants. In both instances, holes are drilled into the timbers at a slight to steep angle at 1.2-m intervals, and a chemical is inserted into the holes, which are then sealed with either preservative-treated wood dowels or, more recently, ''removable plastic plugs (Morrell 1996). The chemical then diffuses through the wood to kill any fungi present and provides protection against renewed fungal attack. The rates at which fungi are killed and the subsequent protective period vary widely with the chemical used (Graham 1973, 1979; Highley and Eslyn 1982; Morrell and Corden 1986; Ruddick 1984).

One commonly used treatment is metam sodium, which contains 32.7 percent sodium *n*-methyldithiocarbamate that decomposes to produce a range of volatile compounds (Elson 1966, Miller and Morrell 1990, Morrell 1994). The most important of these is methylisothiocyanate (MITC), a highly effective fungicide. Metam sodium has been widely used for remedial treatment of wood utility poles and typically provides 5 to 7 years of protection. This chemical has been used for more than three decades in utility poles, but few data are available on its performance in bridge timbers. Intuitively, fumigant movement in timbers should be similar to that in poles, but timbers are usually used horizontally and generally have a higher surface-to-volume ratio that could permit somewhat faster loss of fumigant. In addition, the preservative-treated shell is typically shallower in bridge timbers, again creating the potential for more rapid chemical loss. In this article, we examine the performance of metam sodium over a 12-year period in Douglas-fir bridge timbers in western Oregon.

Materials and Methods

Creosote-treated Douglas-fir timbers in a bridge located in Marion County, Oregon, were selected for the present study. The bridge was remedially treated with metam sodium by a commercial contractor. Four treatment holes were drilled 0.6 m from the end of each timber, and two treatment holes were drilled at 1.2-m intervals along the center of each timber. Metam sodium was applied to each treatment hole according to the dosage guidelines listed on the pesticide label, and the holes were plugged with tight-fitting wood dowels. Fumigant performance was assessed by measuring residual chemical in the wood as well as by

The authors are, respectively, Professor, Senior Faculty Research Assistant, and Senior Faculty Research Assistant, Dept. of Wood Sci. & Engineering, Oregon State Univ., Corvallis (jeff.morrell@oregonstate.edu [corresponding author], connie.love@oregonstate.edu, camille.freitag@oregonstate.edu). This paper was received for publication in April 2013. Article no. 13-00037.

Forest Prod. J. 63(3/4):88–90.
doi:10.13073/FPJ-D-13-00037

Table 1.—Methylisothiocyanate (MITC) levels in increment core segments removed from Douglas-fir timbers sampled 1 to 12 years after treatment with metam sodium.[a]

Structure	Core position	Mean (SD) MITC content (μg/g ovendried wood)						
		Year 1	Year 2	Year 3	Year 6	Year 7	Year 10	Year 12
3	Inner	**34** (46)	**39** (78)	**21** (35)	**40** (46)	15 (39)	17 (12)	18 (16)
	Outer	12 (14)	**70** (81)	**44** (76)	**78** (97)	**66** (33)	19 (13)	16 (14)
10	Inner	**58** (64)	**126** (111)	**107** (61)	**54** (32)	**32** (18)	15 (12)	9 (8)
	Outer	**47** (38)	**60** (49)	**97** (51)	**51** (31)	**29** (20)	10 (8)	15 (12)
15	Inner	**21** (29)	**83** (87)	**62** (28)	**51** (38)	**43** (23)	**25** (26)	9 (8)
	Outer	**26** (47)	**86** (86)	**94** (89)	**56** (42)	**37** (25)	**20** (19)	**20** (10)
20	Inner	**50** (61)	**80** (90)	**63** (53)	**45** (26)	**48** (32)	**42** (46)	11 (7)
	Outer	**50** (49)	**76** (105)	**104** (106)	**59** (26)	**54** (35)	**22** (16)	16 (9)
25	Inner	**30** (33)	**73** (97)	**64** (50)	**38** (23)	**37** (21)	**29** (13)	13 (6)
	Outer	**40** (46)	**70** (68)	**42** (29)	**42** (23)	**42** (21)	16 (11)	**21** (6)
30	Inner	**78** (60)	**84** (81)	81 (65)	**34** (19)	**43** (23)	**24** (11)	—
	Outer	**88** (88)	**80** (79)	60 (42)	**39** (25)	**30** (16)	**21** (11)	—
35	Inner	**29** (35)	**75** (94)	64 (66)	**34** (41)	**46** (19)	**21** (19)	—
	Outer	**35** (54)	**82** (138)	**33** (34)	**48** (40)	**47** (29)	6 (6)	—
40	Inner	—	**71** (108)	—	—	—	—	—
	Outer	—	**94** (84)	—	—	—	—	—

[a] Values represent the results of 12 analyses. Numbers in bold indicate MITC levels above the toxic threshold of 20 μg/g ovendried wood. Inner and outer core positions = the innermost and outermost 0- to 25-mm-long segments of the increment cores removed from the timbers. Dashes = timbers not sampled.

culturing to detect the presence of viable fungi 1, 3, 7, 10, and 12 years after treatment.

Increment cores were removed from near the top and bottom edges 0.6 m away from the original treatment holes on each of eight timbers. The outer, preservative-treated shell was discarded, and then the outer and inner 25 mm of the remaining core were individually placed into test tubes containing 5 mL of ethyl acetate. The tubes were capped and stored for 48 hours at room temperature. The ethyl acetate was then poured off into a separate tube, and the extracted increment core segment was oven-dried and weighed. The ethyl acetate extract was analyzed for residual MITC by gas chromatography using a Shimadzu gas chromatograph equipped with flame photometric detector and filters specific for sulfur (Zahora and Morrell 1988). MITC levels were quantified by comparison with prepared standards and were expressed as micrograms of MITC per gram of ovendried wood (μg/g). Based on the results of previous studies in our laboratory, a minimum MITC level of 20 μg/g is the presumed protective threshold.

The section of increment core remaining after the treated wood and fumigant assay segments were removed was used to detect the presence of decay fungi. These core segments were passed through a flame to kill surface organisms, placed on 1.5 percent malt extract agar in plastic petri dishes, and incubated at room temperature (20°C to 23°C) for 30 days. Fungi growing from the cores were examined for characteristics typical of Basidiomycetes, a class of fungi containing many important wood decayers.

Results and Discussion

One year after treatment, MITC levels above the 20-μg/g minimum protective level were present in seven of eight timbers (Table 1). MITC levels tended to vary widely among sampling locations in a given timber. Chemical levels did not appear to vary consistently between the top and bottom of each timber, suggesting that wood characteristics rather than vertical position in a timber had a greater effect on chemical distribution. As a result, the analyses for the top and bottom were combined for comparison (Table 1).

Two years after treatment, MITC levels were increased slightly, and all timbers contained MITC at levels above the presumed protective threshold at all sampling locations. MITC levels continued to remain above the threshold in most timbers sampled 3, 6, and 7 years after treatment, although there was a steady decline over time (Fig. 1). The presence of protective MITC levels in metam sodium–treated timbers 7 years after treatment was surprising, because this treatment is considered to provide the shortest protective period of any fumigant treatment (Morrell and Corden 1986).

Seven years after treatment, MITC levels were above the presumed protective threshold in most timbers but declined sharply thereafter. Levels were above the toxic threshold in 78 percent of the samples at the 7-year mark but dropped to 41 and 25 percent at 10 and 12 years, respectively. Interestingly, four of the five timbers sampled 12 years

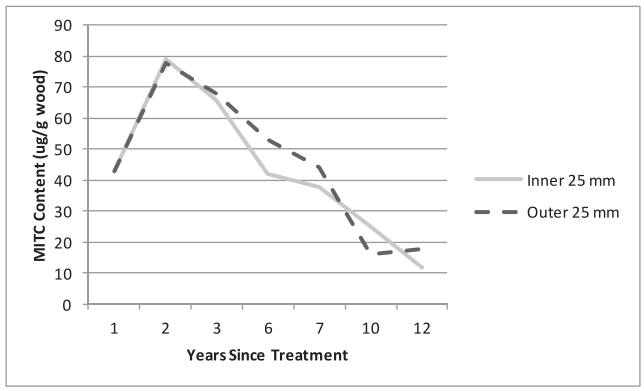

Figure 1.—Methylisothiocyanate (MITC) content in increment cores removed from five to eight Douglas-fir timbers sampled 1 to 12 years after treatment with metam sodium. Inner and outer represent the innermost and outermost 25 mm of the increment cores removed for the timbers.

Table 2.—Isolation frequency of decay fungi from Douglas-fir bridge timbers before and 1 to 12 years after treatment with metam sodium.

	Mean % of cores with decay fungi[a]							
Structure	Year 0	Year 1	Year 2	Year 3	Year 6	Year 7	Year 10	Year 12
5	—	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	8
15	0	0	0	8	0	0	0	0
20	—	0	0	0	0	0	0	0
25	0	0	0	8	0	0	0	0
30	29	0	0	0	0	0	0	—
35	13	0	0	8	0	0	0	—
40	0	—	8	—	—	0	0	—
Avg.	8	0	1	4	0	0	0	2

[a] Values represent the mean percentage of 12 cores containing decay fungi. Dashes = timbers not sampled.

after treatment still contained MITC levels above the threshold at several sampling locations, and all timbers contained detectable MITC levels. The presence of detectable MITC in timbers sampled 12 years after fumigation is inconsistent with the results of previous trials in utility poles and suggests that bridge timbers more effectively retain chemical (Morrell and Corden 1986). This may reflect differences in permeability, because timbers contain higher proportions of less permeable heartwood while poles have a thicker band of more permeable sapwood. Alternatively, it may reflect differences in primary treatment or checking pattern.

The absence of decay fungi can serve as an indicator of fungal protection. Decay fungi were cultured from 8 percent of the increment cores removed from the timbers before treatment, representing fungi in two of eight timbers, but no evidence of visible decay was found (Table 2). No decay fungi were isolated from any timber sampled 1 year after treatment, suggesting that the fumigant treatment was effective. These results were consistent with measurements of MITC levels. Incidence of decay fungi increased 2 and 3 years after treatment, with fungi detected in one and three timbers, respectively. These results suggest that fungi had begun recolonizing the wood, despite the toxic levels of MITC detected in the wood. It is unclear why fungal colonization increased so sharply at these times, particularly because no decay fungi were isolated from timbers sampled 6, 7, or 10 years after fumigation. The inconsistent fungal isolations made it difficult to use these data as a measure of fumigant performance, although the low isolation frequencies at least indicate that fungal colonization had not increased over time.

Conclusions

Effective levels of MITC were produced in Douglas-fir timbers sampled 1 year after metam sodium treatment. These levels were generally capable of reducing the incidence of fungal colonization, although viable fungi were sometimes isolated at selected sampling points. However, no evidence of internal decay was detected in increment cores at any sample time. Effective MITC levels were found in most timbers up to 10 years after treatment. This performance was far better than that found in similar trials of Douglas-fir pole sections. The results indicate that a 10-year retreatment cycle should be sufficient to provide continued protection to Douglas-fir bridge timbers.

Literature Cited

Elson, J. E. 1966. Fungitoxicity of sodium N-methyldithiocarbamate (Vapam) and its decomposition products. Master's thesis. Oregon State University, Corvallis.

Graham, R. D. 1973. Fumigants can stop internal decay of wood. *Forest Prod. J.* 23(2):35–38.

Graham, R. D. 1979. In large timber fumigants stop rot that good design could have prevented. *Forest Prod. J.* 29(9):21–27.

Highley, T. L. and W. E. Eslyn. 1982. Using fumigants to control interior decay of waterfront timbers. *Forest Prod. J.* 32(2):32–34.

Miller, D. B. and J. J. Morrell. 1990. Interactions between sodium N methyldithiocarbamate and Douglas-fir heartwood. *Wood Fiber Sci.* 22(2):135–141.

Morrell, J. J. 1994. Decomposition of metham sodium to methylisothiocyanate as affected by wood species, temperature, and moisture content. *Wood Fiber Sci.* 26:62–69.

Morrell, J. J. 1996. Wood pole maintenance manual. Research Contribution 14. Forest Research Laboratory, Oregon State University, Corvallis.

Morrell, J. J. and M. E. Corden. 1986. Controlling wood deterioration with fumigants: A review. *Forest Prod. J.* 36(10):26–34.

Ruddick, J. N. R. 1984. Fumigant movement in Canadian wood species. IRG/WP/3296. International Research Group on Wood Preservation, Stockholm.

Zahora, A. R. and J. J. Morrell. 1988. Decomposition of methylisothiocyanate in Douglas-fir heartwood. *Forest Prod. J.* 38(10):46–52.