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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

THE REDUCTION OF THE FIRE HAZARD OF THATCHED ROOFS

by

G.H.J. Elkins

SUMMARY

Three methods of reducing the fire hazard of thatched roofs have been examined. The first method was based on the use of a flexible incombustible and insulating layer between the thatch and the roof and may be applied to new roofs. The second consisted of the injection of an intumescent paint into the thatch and may be used for existing roofs. The third method consisted of covering the thatch with a thin layer of cement slurry and has potential application for use in certain tropical countries where the appearance of the thatch is not important. All these treatments improved the resistance of the thatched roof to ignition or penetration by fire.

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Introduction

In previous work carried out by the Joint Fire Research Organization, two traditional methods of reducing the fire hazards of thatched roofs by pre-treatment of the whole of the thatch material itself with water soluble fire retardant additives were examined (1) (2). The work indicated that these treatments could not be recommended since they were not effective after weathering for about a year and also they caused the thatch to deteriorate.

Further tests have now been carried out in which three other methods for reducing the fire hazard of thatch have been investigated. These three methods were devised for use in three different situations as follows, the protection of new roofs, the protection of existing roofs and the protection of roofs in tropical countries where the appearance of the roof is not of prime importance. This report gives an account of the tests carried out but first the techniques used and the reasons for their use are described in some detail.

Techniques

(1) Technique for new roofs

Thatch, when ignited, gives rise to a very intense fire which usually results in serious damage to the roof timbers and interior. Some experiments performed in Denmark (3) indicated that restricting the flow of air to the burning thatch by lining the inside of the roof with an incombustible and impermeable lining reduced the intensity of the fire considerably. If an incombustible lining were imposed between the thatch material and the roof timbers, it would obviously give a degree of protection to the roof structure. However a solid barrier such as asbestos wood if laid over the roof timbers would make subsequent thatching operations almost impossible.

For these reasons the method adopted for new roofs was a modification of the Danish method and it was based on the inclusion of a flexible insulating layer directly below the thatch. For this purpose, use was made of the excellent thermal resistance of mineral wool, which is available in blankets of varying thickness. For these tests blankets of 1" nominal thickness were used. A diagrammatic sketch of a section through the roof is shown in Fig 1. The woodwork of the roof was first painted with a fire retardant paint; in this case an intumescent paint was used. A layer of 1.5" mesh chicken wire was then stapled over the top of the woodwork. Next a layer of mineral wool, overlapping at joints was placed on the chicken wire, which acted as a support for the mineral wool. The roof was then thatched using spikes and rods to secure the thatch. Thus the mineral wool layer was only pierced by a spike directly above a beam and was then compressed around the spike as the thatch pressed down on it sealing any gap made in the mineral wool layer.

(2) Technique for existing roofs

With an existing roof it is impossible to insert a solid thermal barrier between the thatch material and the roof timbers, without completely removing and relaying the thatch. Useful protection of the roof space would be obtained by lining the roof space with an incombustible lining such as asbestos wood, but such a lining, especially on a roof secured by tying, makes subsequent rethatching difficult.

For these reasons the technique adopted for use in the present experiments was to inject intumescent paint into the body of the thatch at a sufficient depth below the surface that would prevent it being washed out by rain and yet would swell during a fire and form a fire resistant layer in the thatch itself. The paint was injected at a depth of 6" through a row of thin nozzles (Plate 1) which were forced into the thatch, in the form of a cream which ran down the interstices of the thatch. The amount of paint applied was 0.2 lb/ft².

(3) Technique for roofs in tropical countries

Thatched roofs in many tropical countries are used solely as the cheapest form of roofing material available, the external appearance of the roof being of less consequence. The application of some cheap fire resistant material which completely alters the external aspect of the roof was therefore considered. Traditional coatings such as dried mud are washed away by heavy rains, and this pointed to the use of some material such as cement which sets hard and is relatively weather resistant. The technique used in the tests consisted of applying a thin slurry of sand/cement to the surface of the roof and allowing this to harden to form a solid skin.

Experimental

Thatch Panels

Thatching advisers of the Rural Industries Bureau constructed eighteen panels of thatch for use in the test. Three thatching materials were used viz:- Norfolk Reeds, Combed Wheat Reeds and Random Straw. These materials were thatched onto wooden frames which were constructed to simulate a typical roof structure. The finished panels measured 4 ft x 4 ft and the tops and sides of the panels were bounded by $\frac{3}{4}$ " thick wooden boards (Plate 2). Six panels of each thatching material were constructed. Three panels of each set of six were constructed using the "new roof" technique, and the other three panels in each set were used either as controls or for the tests of the "existing roof" and "tropical roof" techniques.

Tests

Two methods of testing were used. The first method was a modified version of B.S. 476 : Pt 3 and the second a test in a wind tunnel.

Modified B.S. 476 : Pt 3 test

This test was carried out on panels built according to techniques (1) and (3) above. The test from which it was derived, B.S. 476 : Pt 3, is a test of the fire resistance of a roof surface exposed to external radiation and requires that the edges of the sample be sealed in a frame. The prepared panels, when tested under a Modified B.S. 476 : Pt 3, were therefore modified by cutting away the projecting eaves and boarding in this edge so that the thatch material was completely enclosed. Panels so prepared had a larger surface area than is required by B.S. 476 : Pt 3, but it was found impossible to prepare regulation size samples and still retain a typical roof structure. The modified panels were fitted with a wooden sub-frame 33 inches square which fitted the B.S. apparatus. The exposed areas at the backs of the panels were boarded in and all air gaps sealed with vermiculite plaster. The edges of the panel surfaces were also sealed with vermiculite cement which extended over the wooden surround.

Because of the open structure of thatch it was found impossible to get a pressure difference of 1.5 mm water gauge as laid down in B.S. 476, and all tests were conducted at .1 mm water gauge which corresponded to an air flow of 1 ft/min through the surface of the sample.

Wind Tunnel Tests

Wind tunnel tests were also carried out on panels built according to techniques (1) and (2) above.

In previous work (1) it was found that treated panels of thatch responding well under a modified B.S. 476 : Pt 3 test, did not behave so well in a flowing air current of 10 ft/sec. Consequently some panels of thatch constructed using the "new roof" technique and also two panels injected with intumescent paint were tested in a wind of 10 ft sec. A typical test is shown in progress in Plate 3.

The first wind tunnel test showed that ignition of vapours seeping through the back of the panel was most probably effected by flames and sparks penetrating under the eaves and round the sides of the panel. In subsequent tests the gap under the eaves was sealed up with vermiculite plaster and the panels surrounded by an asbestos wood shield to deflect surface flaming (Plate (3)). One attempt was made to reduce the seepage of fumes through the back of the thatch by painting the inner exposed surface of the mineral wool layer of a "new roof" panel with intumescent paint which was allowed to harden before testing the panel in the wind tunnel.

Results

Results of the modified B.S. 476 test are shown in Table 1. According to this test both techniques gave a substantial improvement of the fire resistance of the thatch. If the test had not been modified in order to allow its use with the thatch panels then the new roof modification would have been classified as EXTERNAL S.AD. and the roof lined with cement and slurry as EXTERNAL S.AA.

The results of the wind tests are given in Table 2. Comparison of the tests with the "new roof" modification given in the table (Tests 1 - 3) with those in Table 1 show that the penetration of the roof by fire was much more rapid under the conditions of wind test than they were in the modified British Standard test. Comparison between tests (3) and (4) in Table 2 indicated that painting the inside of the mineral wool with an intumescent paint increased the time taken for the fire to penetrate the roof. Comparison of tests (5) and (6) with tests (1) and (2), showed that the "existing roof" treatment was as good or better than the "new roof" treatment for preventing penetration of the roof in this test. In all tests failure occurred due to the flashing of flammable vapour evolved through the inside surface of the roof; except for test 1 however it was not clear whether ignition occurred by a flame penetrating the roof or travelling round the edge of the specimen.

There were not enough panels available to allow control wind tests to be carried out on untreated thatch. A comparison is possible with results given in a previous report for panels of Norfolk Reed which had been treated with a soluble fire retardant and exposed to weathering for one year(1). In two tests the time to penetrate was 0.5 and 1.2 minutes respectively and it would be expected that the performance of untreated thatch would be comparable to this. This performance is very much worse than that indicated by tests 1 and 5 in Table 2 for the "new roof" and "existing roof" modification respectively.

Discussion

The rate of burning of the thatch and the effects of such burning on the roof structure appear to have been substantially reduced by the "new roof" technique. However the results of the wind tests indicate that there is still room for improvement when this method is used. To this end the mineral wool layer might, with advantage be made thicker and special care must be observed that thin patches are not made in this layer when handling the material. Painting the upper surface of the mineral wool i.e. the

surface on to which the thatch is laid, with intumescent paint would probably reduce the seepage of ignitable vapours to a minimum, though further experiments would be necessary to prove the point. Sealing the space between the top course of brickwork and the woodwork at the eaves would also reduce the rate of burning and the chances of ignition within the roof space.

The injection of intumescent paint into the thatch as used in the "existing roof" technique appears to have reduced the rate of burning considerably. When this technique was used, Norfolk Reed behaved better than Combed Wheat Straw; a possible reason for this is that the more regular interstices of Norfolk Reeds allowed the paint to form a more complete and uniform layer than with Combed Wheat Reeds.

The panel of thatch covered with cement slurry survived the modified B.S. 476 : Pt 3 test, and as a result three panels (coated with the slurry) have been placed on an exposure site to weather, together with a control panel of Random Straw. Neither the "existing roof" or the "new roof" modification should be liable to undue deterioration due to ageing or weathering.

The above tests show that it is possible to achieve a substantial reduction of the fire hazard of thatch by the use of the various protective measures. Indeed, by combining the "new" and "existing" roofing techniques and by the provision of a solid incombustible lining, such as asbestos wood, inside the roof, quite a high standard of fire resistance could probably be obtained. The structure might well withstand the effects of the total burning of the thatch without damage to the roof members or interior. The limitation would of course be in the cost of the roof. It should also prove possible to reduce the fire load by the "new roof" technique, as the thermal insulation would be provided by the mineral wool, and the thatch material would only need to be a rain shedding layer. Any reduction in the thickness of the thatch layer would help to reduce the total cost of the roof.

Conclusion

1. The "new roof" technique described increases substantially the time for fire to penetrate through the roof. This technique is capable of modification to give even greater improvement of performance.
2. The "existing roof" technique described also gives an improvement in performance comparable to the "existing roof" technique.
3. The "new" and "existing" roof techniques are complementary and should when used together give a performance better than either alone.
4. The cement slurry technique makes ignition of a thatched roof from an external source virtually impossible. Weathering tests are now in progress to determine the durability of this method.

Acknowledgments

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References

1. F. R. Note 479. Water soluble fire retardant treatments for thatched roofs.
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2. Internal Note 129 Soluble fire retardants for thatched roofs.
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Table 1

Results of modified BS 476 Pt 3 test

Test No.	Thatch Material	Treatment of Thatch	Treatment of Roof Structure	Time to ignite	Time to Penetrate Mins	Remarks
1	Norfolk Reed	None	"New Roof"	N.I.	N.P.	Applied suction .1 mm WG in all tests
2	" "	None	None	N.I.	26	
3	Combed Wheat Reed	None	"New Roof"	N.I.	N.P.	
4	" "	None	None	1 min 55 secs	17	
5	Random Straw	None	"New Roof"	2 min 30 secs	N.P.	
6	" "	None	None	1 min	9	
7	Combed Wheat Reed	Cement Slurry	None	Not ignited by applied flame	N.P.	Panel eaves not modified. Surface cracked and some slight flaming at cracks and eaves

N.P. No penetration in the test period (60 mins.)

N.I. No ignition after 5 minutes exposure to a radiant source.
in accordance with BS 476 Pt 3.

Standard Test flame then applied

Table 2

Results of wind tunnel tests at 10 ft sec.

Test No.	Thatch Material	Treatment of Thatch	Treatment of Roof Structure	Eaves	Time to Penetrate Mins	Remarks
1	Norfolk Reed	None	"New Roof"	Not Sealed	13	Ignited under eaves
2	Combed Wheat Reed	None	"New Roof"	Sealed	23	Panel in asbestos wood surround, vapour ignited behind mineral wool
3	Random Straw	None	"New Roof"	Sealed	8.5	" " " "
4	Random Straw	None	"New Roof" inside of mineral wool coated with intumescent paint		14.	Intumescent paint flaked off in some areas before frothing
5	Norfolk Reed	"Existing Roof"	None	Not Sealed		After ignition, all combustion ceased after 6 mins. Panel reignited, all combustion ceased after a further 20 mins.
6	Combed Wheat Reed	"Existing Roof"	None	Sealed	23	Panel in asbestos wood surround. Vapours ignited behind thatch.

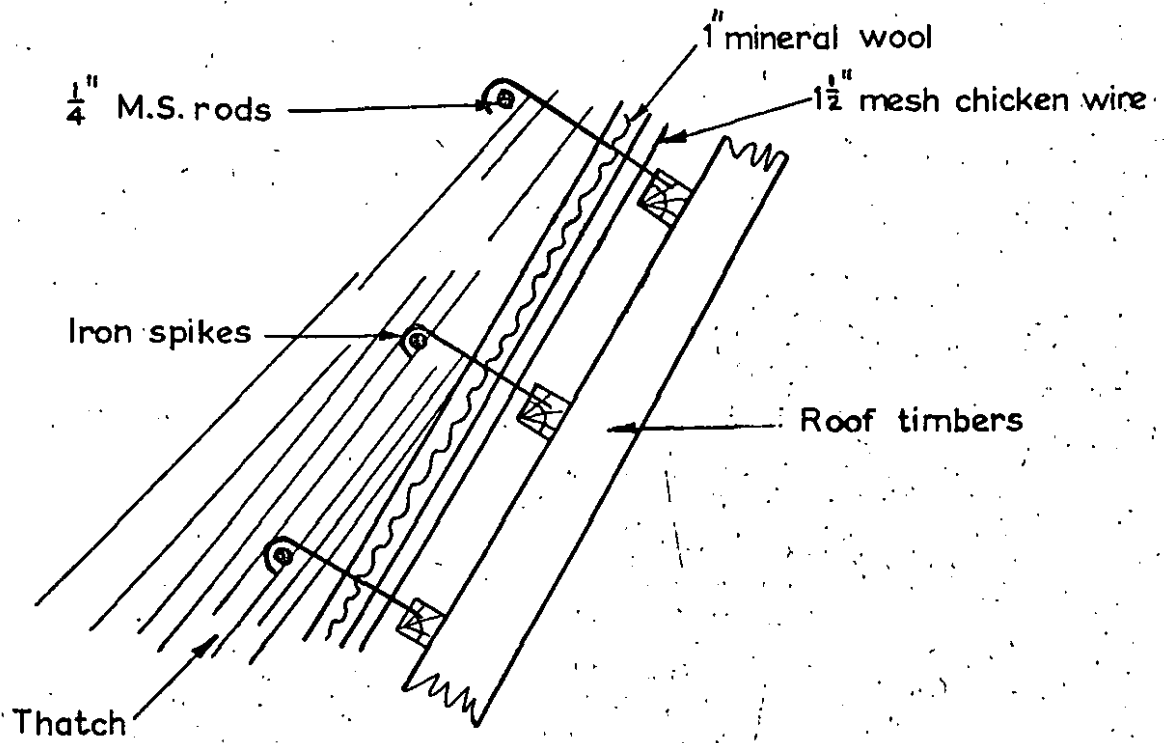


FIG.1. DIAGRAMMATIC CONSTRUCTION OF TEST PANEL

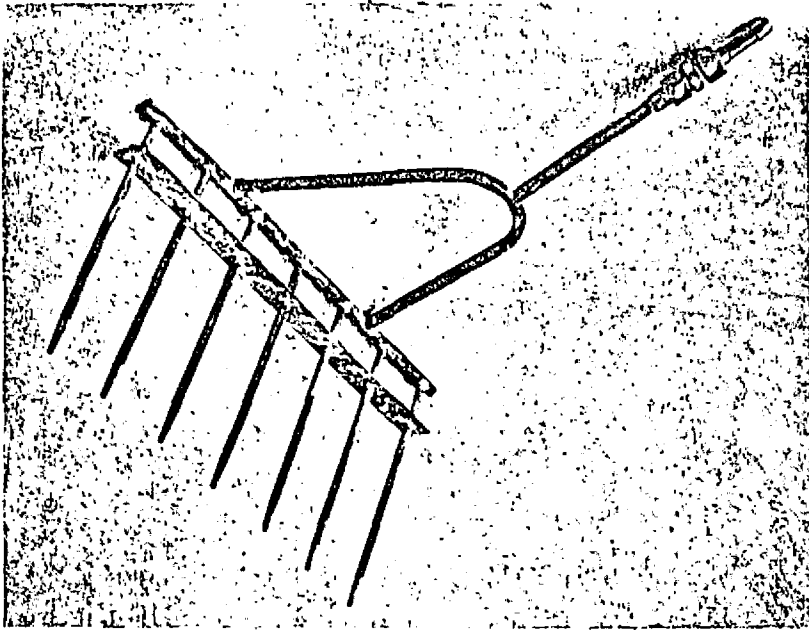


PLATE 1

Injection Nozzle Array

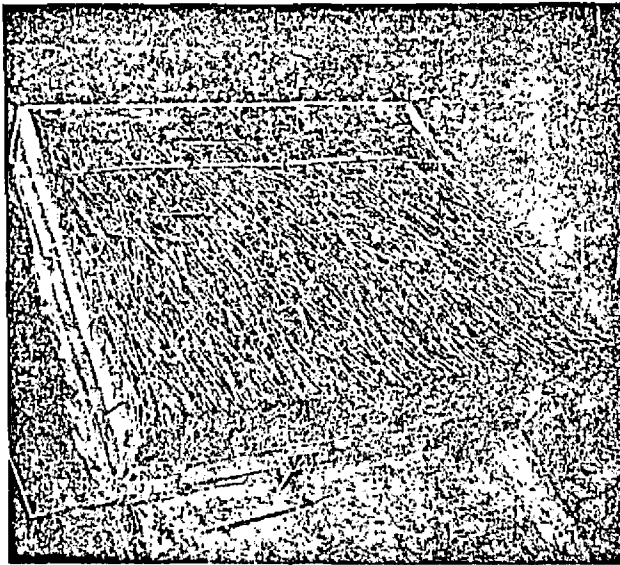


PLATE 2

Typical Unmodified Test Panel

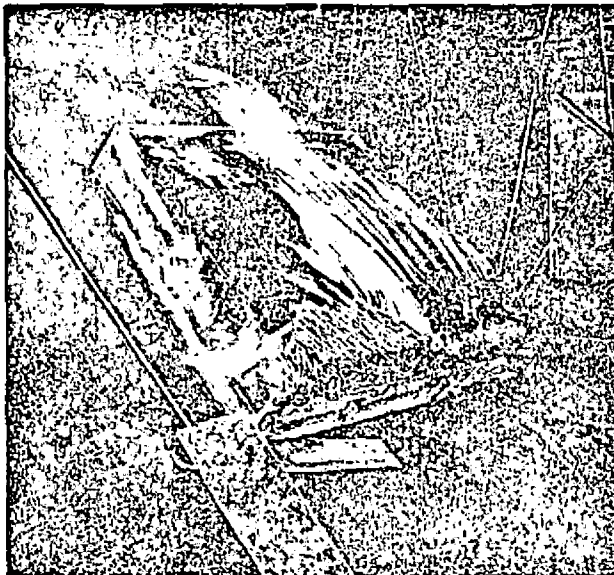


PLATE 3

Typical Wind Tunnel Test in Progress