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EFFECT OF OUTDOOR WEATHERING ON THE LIFE OF FORESTRY SAFETY HELMETS

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Figure 1 - Helmet exposure boards and climate monitoring station

SUMMARY

The study aimed to determine the effect of outdoor weathering, in particular ultra-violet light (UV_a), on the effective life of commonly used models of safety helmets in forestry operations.

The study involved three helmet models and five colours, including both the NZS410 fluorescent lime/green and HC43 fluorescent pink (watermelon) coloured helmets.

Helmets were attached to north facing exposure boards set at 45° to ensure maximum sunlight exposure throughout the day. Two helmets of each model and colour were systematically shock tested at three-monthly intervals.

CONCLUSIONS

- The effective life of helmets exposed to outdoor weathering ranged from 13.5 to 36 months.
- Both of the fluorescent coloured helmets survived until the end of the 36-month test period.
- Helmet colour had little influence on helmet failure rate.

INTRODUCTION

Forest workers' safety helmets must comply with the requirements of New Zealand Standard 5806:1980 *Specification for industrial safety helmets (medium protection)*. The effective life of the helmets has been set by the Standard at no more than three years from the time the helmet was issued to the wearer. The introduction of the fluorescent coloured high visibility forestry helmets resulted in some controversy as they were believed by some wearers to have a shorter effective life than the standard coloured helmets. This generated some concern within the forest industry, as many forestry companies encouraged the use of the fluorescent coloured helmets in an attempt to increase worker visibility and safety.

There has been little southern hemisphere research undertaken on the effects of outdoor weathering on the effective life of safety helmets. The most recent large scale study was undertaken by Telecom Australia (Boast and Impey, 1987). While being a good guide, the Telecom study was not representative as only white helmets were tested. The use of only white coloured helmets limited the study's value in that the white colour is one of the more effective colours for resisting climatic degradation due to its high degree of light reflectance. Furthermore, there was no indication that the helmets used in the Telecom study were either available in, or representative of, helmets used in New Zealand.

Other helmet weathering studies undertaken since the late 1970s (Mayer and Salsi, 1980, Noel, 1979 and Jarczyk, 1980) were based in Europe and therefore have little applicability to the New Zealand situation. They reported test results that produced effective helmet life ranging from two to 10 years. Most helmet degradation studies have concentrated on inducing artificially rapid rates of degradation in laboratory situations using ultra-violet light in order to extrapolate the results to actual working situations (Heyns, 1984). The problem with this, as stated by Heyns, is that plastics used in protective helmets react differently in laboratory tests than under actual working conditions.

METHOD

Helmet Type and Colour

Market research undertaken in 1994 indicated three models of helmet accounted for the majority of forestry helmets sold within New Zealand's forest industry. Accordingly, these three models were selected for testing. In total, the trial involved three helmet models and five colours (Table 1).

Table 1 - Test helmets and colours

Helmet Models	Helmet Colours			
A	White	Yellow	Blue	Fluorescent
B	White	Yellow	Blue	N/A
C	White	Yellow	Blue	Fluorescent

Test Methods and Equipment

Helmet testing involved two separate testing procedures. The first test procedure involved the testing, by cold shock absorption, of a sample of each helmet colour and model at three-monthly intervals. The purpose of this test was to locate the time at which the helmets experienced consistent failure rates. Once this time was identified, the second testing procedure was initiated. The second test procedure was a more comprehensive Telarc certified test which involved the testing of nine helmets under a range of conditions. The purpose of this test was to identify which specific attribute of the helmet caused the failures.

Test Procedure One

The test method used was cold shock absorption as it most closely replicated the type of impact likely to be sustained by forest workers in the field. The test involved the dropping of a five kilogram round striker from a height of one metre on to a helmet situated on the headform. The striker incorporated an accelerometer connected to an oscilloscope in order to record the rate of deceleration once the striker hit the helmet (Figure 2).

In accordance with standard NZS 5806: 1980, the helmets were cooled to -10°C for four hours prior to testing to highlight any structural weaknesses in the helmets. By using the cold shock absorption method, a detailed understanding of the helmet's performance was attained as a record of the force being transferred from the metal striker through the helmet and into the head.

The test procedure involved the following:

1. The helmet was removed from the freezer, placed on the headform and secured by two straps placed over the front and back of the helmet.

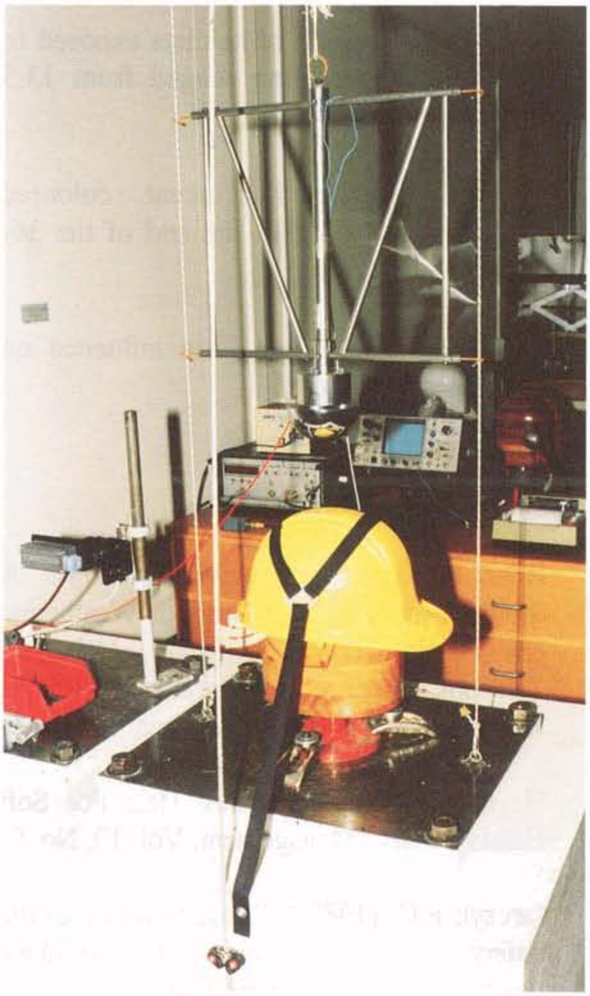

Figure 2 - Helmet test rig showing headform, striker and oscilloscope

2. The striker was raised above the helmet to a height of one metre.

3. The oscilloscope was checked to ensure it was set correctly to record the degree of impact.

4. The striker was released, enabling it to fall freely until it struck the helmet sitting on the headform.

5. The oscilloscope was checked to ensure that it had recorded the degree of impact.

Test procedure one required that two helmets from each model and colour were tested. If both of these helmets failed, test procedure two was undertaken. If only one of these helmets failed, then a further two helmets of the same model and colour were again tested. If one of these second set of test helmets failed, then 50% of the initial sample had failed and the second test procedure was then undertaken. The figure of 50% failure rate was arrived at as being the point at which the helmets should undergo the second test procedure since it was at this point that the helmets showed consistent failure rates.

Test Procedure Two (Telarc Certified Test)

Test procedure two was a more comprehensive test based on NZS 5806: 1980 which involved the testing of nine helmets under a range of conditions; two x cold (-10°C), two x hot (50°C) and two x wet (20°C water temperature) shock absorption tests, two x cold (-10°C) penetration tests and one x lateral rigidity test. The formation of this testing regime was based around the concept of helmet requirements in relation to what would be expected if the helmet was struck by an object in the forest work environment (that is, sailers, shackles and rigging). Consequently, testing for electrical conductivity and flame resistance was not undertaken.

RESULTS

Table 2 - Helmet failure rates

Normal Work Exposure (Months)	4.5	9	13.5	18	22.5	27	31.5	36
Helmet Model				**Pass (P) or Fail (F)**				
A Blue	P	P	P	P	P	P	P	P
A White	P	P	P	P	P	P	P	P
A Fluorescent	P	P	P	P	P	P	P	P
A Yellow	P	P	F	*	*	*	*	*
% Failure Rate (A Model)	0	0	25	25	25	25	25	25
B Yellow	P	P	F	*	*	*	*	*
B White	P	P	F	*	*	*	*	*
B Blue	P	P	F	*	*	*	*	*
% Failure Rate (B Model)	0	0	100					
C White	P	P	P	P	P	P	P	P
C Yellow	P	P	P	P	P	P	F	*
C Blue	P	P	P	P	P	P	P	P
C Fluorescent	P	P	P	P	P	P	P	P
% Failure Rate (C Model)	0	0	0	0	0	0	25	25
% Failure Rate (All Helmets Combined)	**0**	**0**	**36**	**36**	**36**	**36**	**45**	**45**

*** indicates that the helmet has failed an earlier Telarc test and had been removed from the study.**

RELATIVE EXPOSURE TIME

The research design for this trial involved the placing of the helmets in an area that was free of any shadowing effect on a frame set at 45° facing north to ensure maximum sunlight exposure throughout the day (Figure 1). Consequently, the helmets were exposed for a period longer than that experienced by helmets in most standard forest operations.

Estimated maximum solar radiation exposure

Standard forest worker:

9 hrs/day x 235 work days
= 2115 hrs/yr

7 hrs/day x 13 Saturdays
= 91 hrs/yr

Total Exposure/yr
= 2206 hrs/yr

Trial exposure:

9 hrs/day x 365 days
= 3285 hrs/yr

The helmets which were exposed on the trial boards for one year, would have received approximately 1.5 years' exposure in a forest work situation. Therefore, 24 months' test exposure approximated 36 months' normal work exposure.

DISCUSSION

Failure Rates

The results show that the helmets as a group, did not uniformly fail at any one time. Only six of the original 11 helmet colours and models survived to the end of the three-year study period. The first series of failures occurred after 13.5 months' exposure, with, 25% of the A and 100% of the B model helmet and colours failing at this point. Model A helmet failure rate remained at 25% for the remainder of the test period (that is, 36 months' exposure). All of the C model coloured helmets passed the test procedures up to 31.5 months' exposure, at which point the standard yellow coloured helmet failed.

When all of the helmet models and colours were analysed as a group, 36% of the helmets had failed after 13.5 months' exposure. This continued until 45% of all the helmets in the study had failed after 31.5 months' exposure. This raises questions as to the validity of the current Standards requirement that all helmets be replaced after not more than three years service. The same requirement has been in the Occupational Safety and Health Service (OSH) *Safety Code for Forest Operations Part 3 - Logging,* which states that safety helmets shall be replaced after not more than three years after issue to the wearer.

One of this study's objectives was to detect whether helmet colour influenced the rate of helmet failure. However, no trends in failure rates could be detected between light and dark coloured helmets in this study. The B model helmets all failed at the same time, regardless of colour. Both the A and C model helmets also showed no trend as the only helmets to fail were the standard yellow coloured ones, while the darker blue coloured helmets continued to pass the testing process.

Fluorescent Helmet Performance

A second objective of this study was to see how well the fluorescent helmets performed against the more common standard coloured helmets. This study has shown conclusively that the fluorescent coloured helmets performed as well as, if not better, than their standard coloured counterparts. Both of the fluorescent coloured helmets survived the required 36 months' exposure period.

CONCLUSIONS

- The effective life of helmets exposed to outdoor weathering ranged from 13.5 to 36 months.
- Both of the fluorescent coloured helmets survived to the end of the 36-month test period.
- Helmet colour had little influence on helmet failure rate.

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