Motor Vehicle and Pedal Cycle Conspicuity

Part 3: Retroreflective and Fluorescent Materials - Disability Glare of Graphics Markings

Project Number 9/33/13

Undertaken on behalf of

The Department of Environment, Transport and the Regions (DETR)

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1.0 Aim

The aim of the assessment was to determine if the application of retro-reflective graphics material in conjunction with contour markings to the side face of heavy and long vehicles and their trailers could result in disability glare.

Disability glare is the reduction in the ability to see objects due to bright light sources in the visual field. It was assessed in this study by measuring the extent to which the presence of a pedestrian on the road between the truck and an approaching driver could be detected.

For reference, the Draft Regulation XA defines contour markings as ‘a series of rectangular strips intended to be placed in such a way that it shows the contour of the vehicle to the side or rear’. Graphics markings are ‘additional coloured markings intended to be placed within the contour marking’ which are of a lower retro-reflective performance than the contour markings.

2.0 Methodology

2.1 Variables

The study was conducted in the hours of darkness at a local test site. A rig was built to represent the side of a truck and was fitted with side marker lamps and side retro-reflectors.

A worst case scenario was replicated in which the contour and graphics materials would appear at their brightest. This was achieved by using a complete, white contour marking (taking the form of a box outline) and a 2.0m² white graphics marking. These formats maximised the areas of the highest performing materials permissible under the Regulation. (See Appendix 1). The materials were viewed under main beam at a distance from the driver to the truck of 135m which was within the range where the materials would appear at their brightest, and accommodated the 70mph stopping distance of 96m. Vehicle lights from a road passing behind the test rig added visual noise to the test scene similar to that

encountered on the road. The pedestrian wore dark clothing (jeans and grey jacket) and stood 30m in front of the markings.

2.2 Subjects / Participants

14 male and 6 female drivers aged between 22 and 75 participated in the study. 10 participants were young (less than 45 years old) and 10 were old (more than 60 years old).

2.3 Procedure

The participant was positioned in the driver's seat of a Ford Mondeo which was directly behind the truck rig at a distance of 135m from it. The participant was instructed to look into their lap until the experimenter told them to look up. On giving this instruction, the experimenter started a timer and the participant looked along the test site to the truck rig. The participant had to make a decision, as quickly as possible, as to whether there was a pedestrian present between themselves and the truck. On hearing the response the experimenter stopped the timer and recorded the nature of the response and the time taken to give it. The participant then looked down and awaited the next instruction to look up. A total of twenty such presentations were given to each participant, only half of which had the pedestrian in position in front of the markings.

As well as obtaining measures for detecting the pedestrian in the presence of the materials, it was necessary to record the detection performance when there was no material present. This would enable a direct comparison with the conditions representative of current UK roads. The presentation conditions are given below in Table 1.

Table 1: Pedestrian and material conditions assessed

Pedestrian condition	**Material condition**		
	Present	**Absent**	**Total**
Present	5	5	10
Absent	5	5	10
Total	10	10	20

3.0 Results

Table 2 shows the number of times each participant correctly identified the presence or absence of the pedestrian according to whether or not there was material on the truck. Since the mean number of correct detections is greater when the material is in place, this suggests that the presence of the material may have been beneficial to the task. Paired two sample T-tests were conducted which indicated that the presence of the contour and graphics material significantly improved the number of times a pedestrian was correctly detected as present or absent.

Table 2: Number of correct detections of pedestrian presence or absence

Participant	Number of correct detections			
	Material present		Material absent	
	Pedestrian present	Pedestrian absent	Pedestrian present	Pedestrian absent
1	5	5	5	5
2	5	5	4	5
3	5	5	4	5
4	5	5	5	5
5	4	5	1	5
6	5	5	5	5
7	5	5	5	5
8	5	5	0	5
9	5	5	2	5
10	5	5	5	5
11	5	5	5	4
12	5	5	5	5
13	5	5	5	4
14	5	5	5	4
15	5	5	1	5
16	5	5	4	5
17	5	5	0	5
18	5	5	5	5
19	5	5	5	5
20	1	5	3	4
Mean	4.75	5	3.7	4.8
T-probability compared to material absent condition	0.02	0.04		

However, it is not just the overall number of correct detections which is important, but the time taken to make them. Table 3 below shows that the mean time to detect the presence or absence of the pedestrian was quicker when the material was present. This is confirmed as statistically significant by paired two sample T-tests.

Table 3: Time to detect pedestrian presence or absence

Participant	Detection time (secs)			
	Material present		Material absent	
	Pedestrian present	Pedestrian absent	Pedestrian present	Pedestrian absent
1	5.36	5.88	6.38	5.55
2	7.32	6.4	9.62	8.45
3	7.46	18.06	21.01	20.25
4	6.1	5.68	5.64	6.47
5	14.22	13.63	15.96	17.63
6	9.54	11.51	10.71	11.23
7	5.91	5.59	5.37	5.64
8	9.28	12.02	12.32	11
9	9.17	12.99	19.56	14.83
10	4.51	5.42	4.78	5.8
11	4.81	4.21	4.92	4.87
12	4.35	4.4	4.7	4.97
13	6.14	6.66	6.05	7.94
14	6.96	8.33	7.53	8.95
15	5.91	6.79	9.73	7.01
16	7.73	8.67	17.36	8.73
17	8.25	8.03	7.97	9.46
18	8.7	8.85	8.66	10.05
19	7.42	7.68	11.45	9.1
20	21.24	14.92	18.16	19.76
Mean	8.02	8.79	10.39	9.88
T-prest compared to material absent condition	0.02	<0.01		

4.0 Conclusions

The presence of the contour and graphics material is beneficial to the detection of pedestrians in two respects. Firstly, it significantly increases the likelihood of drivers detecting a pedestrian and secondly, it significantly reduces the time taken to make those detections. It seems unlikely therefore that the contour and graphics markings will be perceived to be so bright that any resultant disability glare could lead to the non-detection of a pedestrian.

Appendix 1

Photometric specifications for Contour Markings

TABLE 1

Minimum values for the coefficient of retro-reflection R′ ($cd.m^{-2}.1x^{-1}$)

Observation angle ∝ (°)	Entrance angle β (°)				
∝ = 0.33° (20′)	β1	0	0	0	0
	β2	5	30	40	60
Colour					
Yellow	300	130	75	10	
White	450	200	90	16	

Photometric specifications for Graphics Markings

TABLE 2

Minimum values for the coefficient of retro-reflection R′ ($cd.m^{-2}.1x^{-1}$)

Observation angle ∝ (°)	Entrance angle β (°)				
∝ = 0.33° (20′)	β1	0	0	0	0
	β2	5	30	40	60
Any colour	150	65	37	5	