SIGNS OF RAIN.

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DYNAMIC WARNING SIGNS

For many years a number of systems have been introduced which provide dynamic advice to motorists on the real time status of the road network. The most common of this real-time information has been congestion related allowing motorists to take alternate routes to reduce travel time.

However in the Southern Region of the NSW's Roads and Traffic Authority (RTA), a number of systems have been developed to provide real-time information which can improve road safety by allowing drivers to in some way modify their speed behaviour based on advice on approaching changed road conditions. Such systems use hazard detection devices which continually monitor road conditions to obtain real-time information that can be displayed on changing message signs. In 1995 a 12 km network of fibre-optic variable message signs was connected to 10 fog detection units and 24 speed detection devices to target individual motorists on the appropriate speed behaviour for the visibility. (1) Changeable message signs have also been provided at several locations which are connected to presence detectors to advise drivers when queues build up at sites with restricted sight distances. These displays revert to a different message when queues are not present. (2)

The RTA's Southern Region have now expanded the use of these signs to provide a changeable sign at a sub-standard curve location where wet weather conditions significantly increases the hazard to motorists. In wet weather and when the pavement is wet, the advisory warning provided to motorists changes to reflect the increased risk at the site . This paper provides information on the development of this system and the behavioural response to motorists to the changed advice for different conditions as they travel through the curve.

SITE SELECTION

On the Princes Highway immediately south of the Kiama by-pass is a 2.3 km section of 4 lane road which is built on a winding alignment developed in the first half of the last century. The speed limit is 80 km/hr. An accident study shows that in the 3 year period from 1996 to 1998 65 accidents occurred within the section of which 58 (89%) were in wet weather conditions. This compares to 65% of accidents occurring in wet weather in the next homogeneous section of the Princes Highway immediately to the south.

The 55 accidents are all loss of control accidents suggesting excessive speed on the bends despite the provision of advisory speed warning signs throughout the section and the selective provision of skid resistant pavements at the most frequent accident locations. In 2000 New Jersey kerb treatment together with central median drainage was provided where practical in an attempt to reduce both accident frequency and severity.

ACKNOWLEDGEMENT: Whilst the views and conclusions in the paper are those of the author, the assistance and support of the Roads and Traffic Authority in using work examples is greatly acknowledged.

Within the Kiama bends section, 17 of the accidents occurred at the location selected with 10 of those occurring in the Northbound direction.

SITE DETAILS

The selected site contains a right hand curve on a 4 lane section of the Princes Highway separated by a New Jersey kerb. Annual rainfall is in the order of 120 cm. There is an AADT in excess of 13000 vehicles per day. A curve warning sign is currently located in the approach to the curve with an advisory speed of 65 km/hr.

FIG 1: Selected Site

In establishing the trial site the sign has been converted to a three way sign with displays shown as shown in Fig 2.

Normal (Condition1) Raining (Condition2) Wet Road - No Rain (Condition3)

FIG 2: Variable Sign Arrangement

The different displays are activated by a moisture detection device that is able to detect weather conditions and the amount of precipitation when raining as well as the pavement conditions in terms of dry/moist/wet. (The equipment is also capable of detecting other conditions such as frost and snow which are not relevant at this site.) Details of the display triggers are shown in Table 2. Flashing Lights are attached to the sign for use in the third mode which is assessed as the most dangerous situation (See later comments).

Condition1		Condition2		Condition3	
Weather	Surface	Weather	Surface	Weather	Surface
Clear	Dry	Rain	Dry	Clear	Moist
Cloudy			Moist	Cloudy	Wet
			Wet		

TABLE 2: Display Logic

In order to assess the effectiveness of the system, speed detection loops were place in both lanes as shown in Fig 3. This allowed speeds to be measured during different conditions.

For each vehicle speeds were measured together with records of lane (fast or slow), time of day (to assess day and night effects), rainfall and pavement conditions. Vehicle lengths were also recorded in order to provide data for heavy vehicles and motor cycles.

No changes are proposed to signposting for southbound traffic.

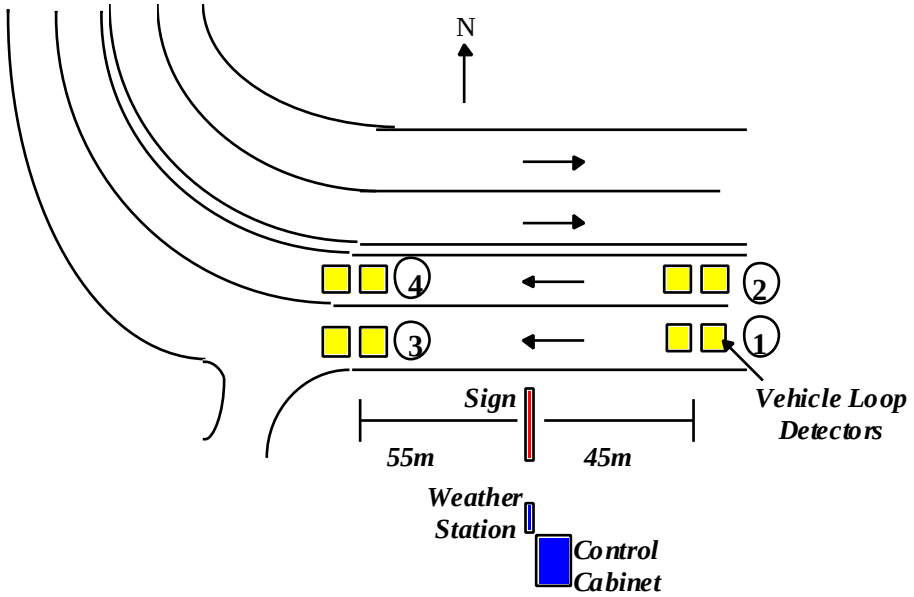

Fig 3: Site Arrangements

The site was commissioned on 30th May and speed measurements were taken for a period before the sign was activated to assess the effects of traditional signposting. These measurements are to be continued until a behaviour pattern had been established in wet as well as dry conditions. At the time of writing the site remains in this conditions as insufficient rain periods have occurred to allow an adequate comparison of variable conditions to be made. When such data has been obtained, the sign is to be commissioned and further data recorded using the displays triggered by the logic shown in Table 2.

RESULTS

Detailed results have been obtained for all conditions. For "Condition1" (clear and dry) a full weeks data has been obtained providing over 50,000 data sets. This data has been obtained on days when no rainfall has occurred. For "Condition2" and "Condition3" only 3573 and 8289 samples respectively have been obtained which is considered insufficient to enable a full statistical comparison of a before situation. In the case of "Condition2" a range of samples are also required for differing precipitation rates to allow a study of the sign's effectiveness in varying rainfall conditions. This would allow further studies to be undertaken at a later date to determine if additional features would be effective in heavy rain conditions when aquaplaning is more likely to occur (e.g. use of flashing lights when the rain exceeds a certain intensity.)

The data has also been separated into four different time of day periods (dawn, daytime, dusk and night) when differing ambient light conditions might be expected to result in differing driving behaviour.

T+

ble 3 shows the average speeds which occur at the two speed detection sites before and after

the sign.

Dawn Day Dusk Night Loops1/2 Loops3/4 Loops1/2 Loops3/4 Loops1/2 Loops3/4 Loops1/2 Loops3/4 Condition1 75 68 75 67 75 67 75 67 Condition2 74 65 71* 62 72 62 69(60 Condition3 73 64 74 65 71 62 71 63 Table 3: Average Speeds by Time Of Day

Speed profiles were also obtained for each of these conditions. Figures 4 and 5 are an example showing the speed profiles for all three conditions during the day and night times.

Not +nexpectedly the early results show that in more adverse conditions vehicles slow down to a greater extent in the approach to the curve (Loops 1/2). This speed reduction varies by time of day with reductions during wet conditions of around 4* km/hr during the day and 6(km/hr at night.

Further reductions of around 8 - 9 km/hr occur as the vehicles enter into the curve. However the early indications (Fig 4a & 4b) are that during the day when the pavement is wet but rain is not falling ("Condition3") the speed profile of vehicles is similar to that for dry conditions.

Fig 4a: Speed Variation during Daytime before sign

Fig 4b: Speed Variation during Daytime after sign

This result is also very apparent at dawn and d usk periods (these results are not shown due to the low sample numbers for adverse conditions).

At night vehicles appear much more likely to maintain the speed reduction which occurs when rain is falling (Fig 5a & 5b).

Fig 5a: Speed Variations at Night before sign

Fig 5b: Speed Variations at Night after sign

A visual examination of the data also shows that the pavement sometimes remains wet or moist in some cases for several hours after the rain has ceased. There is also evidence that dew is responsible for considerable periods of a moist pavement. It is noticeable that the samples numbers obtained to date for "Condition3" are around double those of "Condition2".

Comments

The results achieved to date clearly raise concerns as to the behaviour of motorists in conditions of wet pavements when rain is not falling. The structure of the site arrangements will provide important information to allow further analysis to occur.

THE PROVISION OF THE ENHANCED SIGNPOSTING IS INTENDED TO FURTHER REDUCE THE SPEED OF VEHICLES TRAVELLING THROUGH THE CURVE WITH PARTICULAR EMPHASIS ON MAINTAINING SPEED REDUCTIONS WHEN THE PAVEMENT is wet or moist but no rain is actually falling.

Success in this area w*ill provide a further option for those sites* where significant wet weather problems exist and other treatments have not been fully successful in reducing the *wet weather accident* problem.

References

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