Preferred method for calculating road surface water run-off in New Zealand
TM-2502

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Purpose
To advise on the preferred method of calculating surface water flow and the limited use of the Gallaway method in New Zealand.

Background
The NZTA recommended method used to analyse water flow depth (WFD) in New Zealand was developed by the Road Research Laboratory in the UK in 1968. It was incorporated into the ‘Highway Surface Drainage Design Guide for Highways with a Positive Collection System’, published by the Ministry of Works and Development, for use in New Zealand in 1977. Subsequent studies have shown that this method tends to yield conservative results, overestimating the flow depths for a given pavement shape (slope and length of flow path).

Modifying the design of the pavement to compensate, and therefore reduce this theoretical over-estimation, could lead to undesirable pavement shape. Rates of change in superelevation, vertical profiles and crown positions are each adjusted and the combination of these effects assessed in order to minimise the lengths of the flow paths and therefore the WFD. While these adjustments are usually accommodated within acceptable and safe limits, there have been occasions when the design modifications became excessively complex, producing an unpredictable and therefore unsafe environment for the motorist. If constructed, this safety risk would be ever-present, compared to the risks associated with the design-year event that precipitates the unacceptable WFD.

Gallaway method
In 1979 the US Department of Transportation adopted a method for predicting WFD developed by B.M. Gallaway and detailed in the Texas Department of Transportation Hydraulic Design Manual. This method goes further than the RRL method in that it provides a way to predict the aquaplaning speed based on the estimated WFD. When calculating the WFD, Gallaway’s equation uses the same parameters of flow path, slope and rainfall intensity as the RRL method, but with significantly different indices applied to each, resulting in radically different results. Gallaway also takes into account the texture depth of the pavement, which further reduces the predicted WFD.
Recommended practice

In the absence of more definitive research and/or evidence as to which is the better prediction for the NZ environment, the RRL method of estimating WFD should be used. If the resulting WFD prediction is excessive, then the designer should first look to make adjustments to the shape of the pavement at each individual location, in order to reduce the flow-path lengths. Note that this should be done within the boundaries of normal design practice wherever practicable and care must be taken to not develop an unsafe, unpredictable environment for the road user. The various options investigated in this scenario, and their effects on WFD must be carefully documented.

If the design constraints prohibit an acceptable solution being developed, then the designer may analyse the individual problem areas using the Gallaway WFD formula. The resulting lower prediction for WFD would be considered the lower bound, with the RRL method providing the upper limit for each section of carriageway.

A table, showing both sets of figures for each location should be produced and submitted to the Project Manager for approval.

The Gallaway method should only be used to assess the WFD in areas that have been identified as predicting unacceptably high values using the RRL method. The Gallaway equations should not be used as the default analysis method for any NZ Road Projects.

The Project manager should assess the acceptability of the range of WFD’s predicted by the two methods, against the solutions investigated by the designer in attempting to solve the issues by re-shaping the road surface.

Important – please note

There is an error in the formula on page 3 of the Transport Agency document ‘Highway Surface Drainage Design Guide for Highways with a Positive Collection System’. The factor to which the slope parameter should be raised is 0.2 and NOT 0.5 as written in the formula on that page. However, the correct value has been quoted in the formula reference with Chart 8 on page 37 of that document.

The correct formula is therefore:

\[ d = \frac{0.46(l_f \times p)^{0.5}}{S_f^{0.2}} \]

The flow path slope should be expressed as decimal (mm/m) rather than percentage.

The Project Manager may refer the matter to NZTA National Office for further consideration.

Endorsed by: National Traffic & Safety Manager

Key words | Surface; drainage; run-off; Gallaway;