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	PAVEMENT INFORMATION NOTE	
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The aim of this Report is to demonstrate that once the minimum base thickness has been specified, the very detailed strength measurements, recording and control graphing requirements become quite irrelevant academic exercises. Importantly, **there should be a re-think about the penalties being applied.**

Detailed Concrete Pavement Design Requirement is a Non-event

Issue

D&C Contracts require very detailed 40 year traffic loading estimates and concrete pavement thickness design calculations. These are checked by the Client or an Independent Verifier at 15%, 85% and Final Design levels without ever querying whether there is any real need for this?

Purpose

The of purpose of this paper is to draw attention and demonstrate that the detailed concrete pavement thickness designs in accordance with Austroads Part 2: Pavement Structural Design Guide are expensive academic efforts of no real value when the RTA or Austroads minimum thicknesses are applied and hence constitute an unwarranted waste of public moneys in the ultimate.

Example

The following example is used to demonstrate the relationships between the design parameters of flexural strength, design traffic loading (DTL) and slab thickness and the minimum requirements by RTA and Austroads,

Assumptions

1 Using CRC Pavement with shoulders;
2 40 year design life;
3 DTL = 2e8 HVAG (one way) – 20% HVs
4 Equivalent subgrade strength of CBR 5%;
5 Rural Axle Load Distribution;
6 Load safety factor = 1.2 for 95% reliability;
7 Minimum allowable base thickness 230 mm Austroads. 240 mm RTA.

Pavement Strength

1. Assume average correlation $f_f = 0.8\sqrt{f_c}$
2. 35 MPa compressive = 4.5 MPa flexural for design
3. Normal target strength 45 MPa = 5.4 MPa flexural
4. Due to minimum binder specification, concrete generally 50+ MPa = 5.7 MPa flexural strength
5. Theoretically after 1 year 45 + 10% = 50 MPa or f_f = 5.7 MPa, or
   45 + 20% = 55 MPa or f_f = 5.9 MPa
6. Based on the recent Warringah Expressway pavement testing after 43 years of nominal 17 MPa design mix, there was a 100% strength gain on the target strength. Here in this example this could be = 90 MPa, hence f_f = 7.6 MPa.

Interrelationships of DTL, f_f and Base thickness

A number of designs have been carried out to illustrate the variations in DTL, concrete flexural strength and the base thickness when changing one of the three parameters.

The results are summarized in the following table;

DTL (HVAG)	Flex Strength MPa	Compr.Strength MPa	Base thickness mm
2e8	4.5	32	215
2e8	5.7	51	195
2e8	5.9	54	194
2e8	7.6	90	194
2e8	4.1	26	230
2e8	3.8	23	240
1.2e9	5.7	51	215
1.1e9	5.9	54	215
1.24e9	7.6	90	215
1.3e9	4.5	32	230
5.45e9	5.7	51	230
5.5e9	5.9	54	230
5.7e9	7.6	90	230
1.7e10	5.7	51	240

For easier interpretation, these results have been graphed as below:

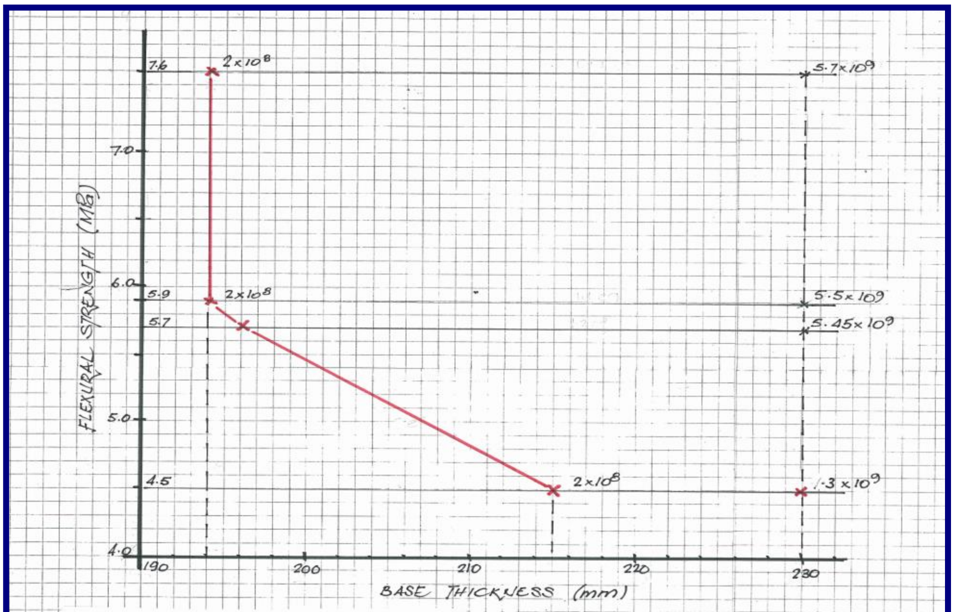

Figure 1 – Base thickness vs Flexural strength

Figure 1 – Flexural Strength vs Base Thickness

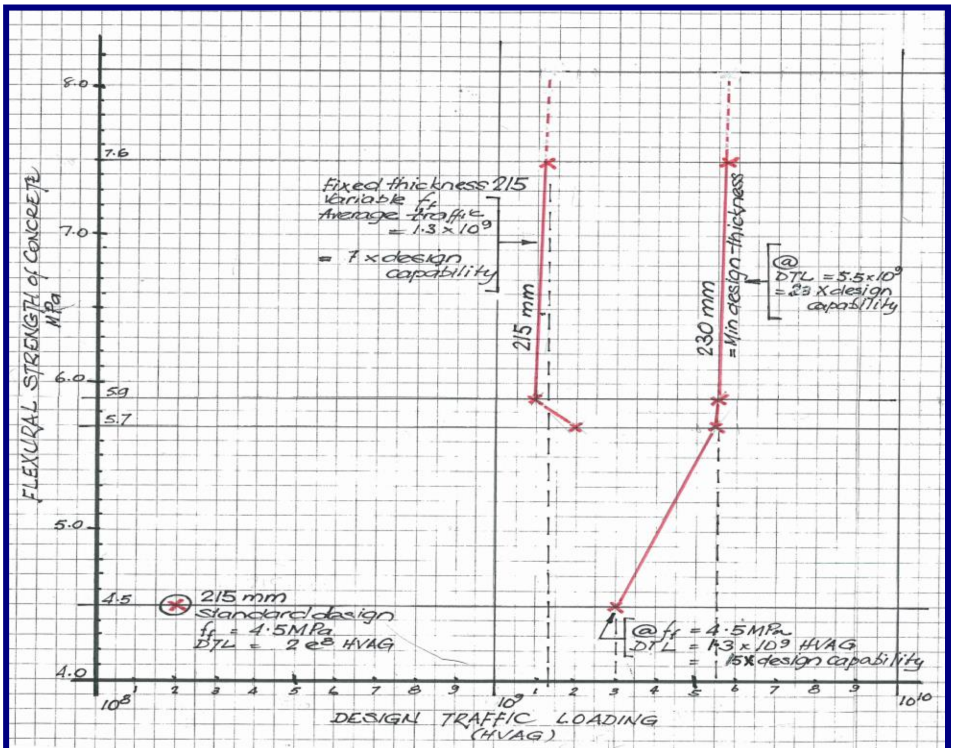

Figure 2 – Flexural strength vs Design Traffic Loading

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Interpretation

Figure 1 illustrates the relationship between the flexural strength and the base slab thickness.

1 For the assumed DTL of 2 x 10^8 HVAG, the minimum design thickness is 215 mm at the flexural strength of 4.5 MPa.
2 If the flexural strength is increased to 5.7 MPa (the equivalent to the theoretical compressive strength of 50 MPa), the design thickness reduces to 195 mm.
3 Here it is interesting to note that there is no reduction in thickness with the increase in flexural strength above 5.9 MPa.
4 If the minimum allowable thickness of 230 mm is adopted then the loading capacity increases to 1.3e9 HVAG or about 7 times the DTL.

Figure 2 illustrates the relationship between flexural strength and Design Traffic Loading.

5 If the 215 mm thickness is used with a higher value of flexural strength, then the average DTL capacity becomes 1.3e9 HVAG or 7 times the design capacity.
6 For higher values of the flexural strength, the base thickness remains virtually constant as both 215 mm and 230 mm from 5.7 MPa onwards.
7 If the Austroads minimum allowable thickness is adopted, then at 4.5 MPa flexural strength the capacity becomes 1.3e9 HVAG or again 7 times greater than the design capacity as also shown in Figure 1.
8 At the 230 mm minimum thickness (RTA), the 5.7 flexural strength pavements can now take about 5.5e9 HVAG, which equates to 28 times the design capacity.

From the table it is interesting to note also that for the DTL of 2e8 and the minimum base thickness of 240 mm, a flexural strength of only 3.8 MPa (compressive strength of 23 MPa) is required.

In Summary:

- The RTA minimum 240 mm base thickness for CRCP of 5.7 MPa flexural strength concrete will have a 40 year design loading capacity of 1.7e10 HVAG.
- This is equivalent to 169,000 Heavy Vehicles per day.
- Assuming that the HVs = 20% of the AADT, this equates to 845,000 vpd.
- If one assumes 15% of the AADT will constitute the peak hour traffic, then this equates to 127,000 vph.
- On the basis of a lane capacity of 2,000 vehicles an hour, a 63 lane carriageway will be required to handle the traffic!

Conclusions

1 With the minimum thickness requirements of 240 mm for CRCP/JRCP and 260 mm for PCP, there should be no requirement for detailed designs for pavement thicknesses as the load carrying capacity of these pavements far exceeds any realistic loading conditions.

2 There is no decrease in the base thickness after the concrete flexural strength reaches about 5.7 MPa.
3 With the minimum base thickness of 240 mm, the 40 year DTL of 2 x 10^8 HVAG can be achieved with a concrete of 23 MPa compressive strength.