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Structural condition assessment
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FWD ON CONCRETE ROADS: LOAD TRANSFER EFFICIENCY, FAULTING AND BEARING CAPACITY

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Given the large Belgium's concrete road network, the BRRC has frequently made many researches with the FWD equipment on rigid structures. The FWD was particularly used in the large number of secondary and rural concrete slab roads existing in Belgium. After many years of service, one of the natural expected degradation of the concrete slab roads is the faulting between slabs phenomenon. Slab faulting has a negative effect on the road condition itself and can over time cause more severe damage to the slabs themselves. Faulting also generates noise which is a concern for road users and local habitants.

The equipment has been then adapted to measure the faulting between slabs and detect voids presence. There are several technical indicators typically used for concrete slab evaluation. These indicators, as the explanations concerning the use of the FWD in this kind of roads, are all referred in the literature [Crovetti & Darter, 1985] [Khazanovich & Gotlif, 2003]. Additionally, with the combined analysis of the load transfer efficiency and the bearing capacity, the BRRC was able to find many interesting results which can be linked to other parallel tests concerning the faulting and the material properties. The 6th FDW User Group Meeting BRRC's presentation gives an overview of some of these findings.

Particular equipments specifications

The adaptation of the FWD for the study of the concrete road slabs consisted on placing two geophones on each side of the place of the impact (at 450 mm and 300 mm). To complete the information for the bearing capacity four other geophones were provided and placed at the impact and other usual positions (at 600, 900, 1500 and 2100 mm).

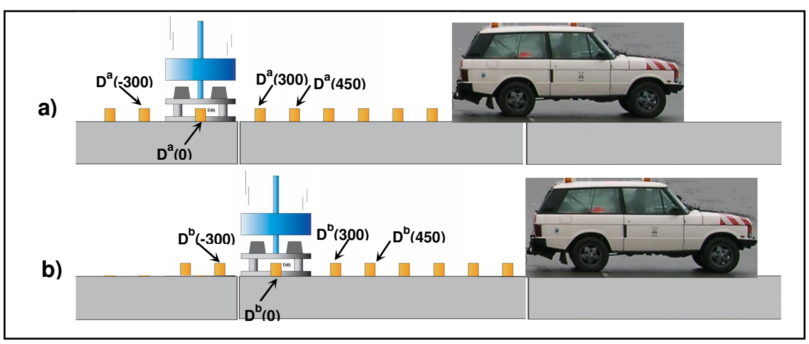

Figure 1 – FWD configurations used to test joints and cracks

Configuration ***a)*** and ***b)*** from figure 1 are set to estimate the load transfer efficiency and to evaluate the faulting amplitude by measuring the relative movement between the slabs when the load falls on each one of them. This measurement can be compared to the faultimeter results.

The Faultimeter is put over the joint between slabs to measure the relative movements of the slabs while an axle of a truck passes from the approach slab to the leave slab (cf. Fig. 2). The

Faultimeter measures the physical behavior of the faulting itself. Figure 2 shows its mechanism. It consists of a stand with three supports (1) and a movable pin (2) serving as the fourth support. A transmission system connects this pin to a dial gauge (3), which indicates the magnitude of the movement in thousands of mm. Figure 2 shows also a typical measurement obtained with the devise. From this curve the front axle is not taken into account. For the 11 tons rear axle two maximums can be observed. The first one (B1) can be measured when the load is on top of the slab before the joint and the second one (B2) when the load is on top of the slab after the joint.

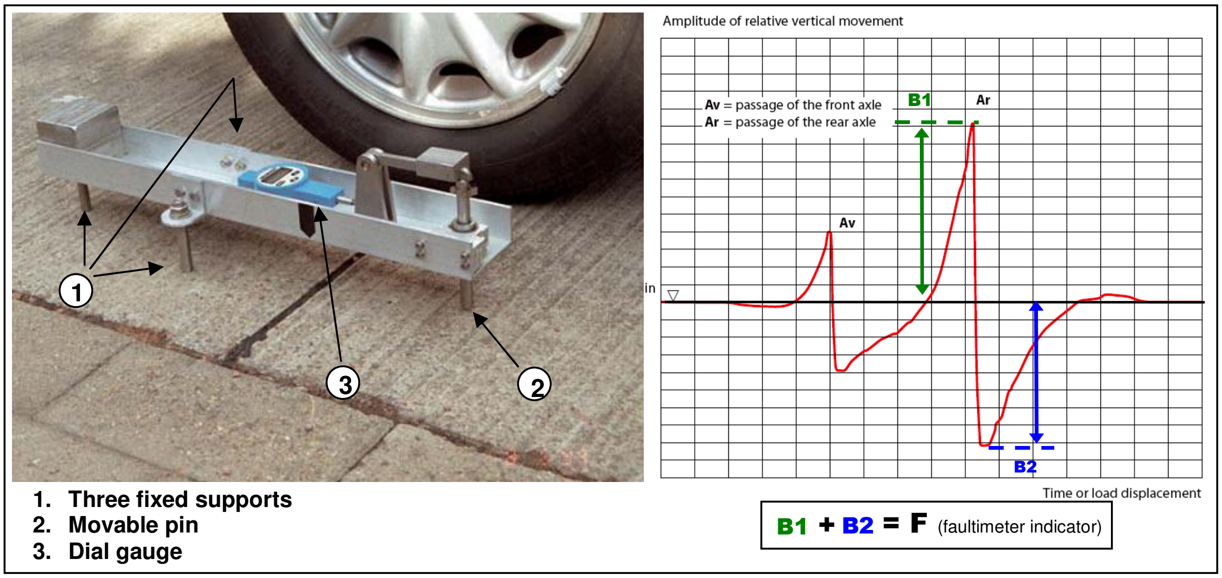

Figure 2 – Faultimeter and typical measurement obtained with this devise

Some findings and consistency between different methods

The comparison between the different indicators and measurements were made in several concrete slabs pavement and continuously reinforced concrete pavement. This comparison has provided some clues to determine the relationship between the different types of methods.

In the case of the concrete slabs roads, the comparison between the LTE and the faultimeter value has permitted to find in which situations both methods will give comparable information about the behavior of the road (cf. Figure 3).

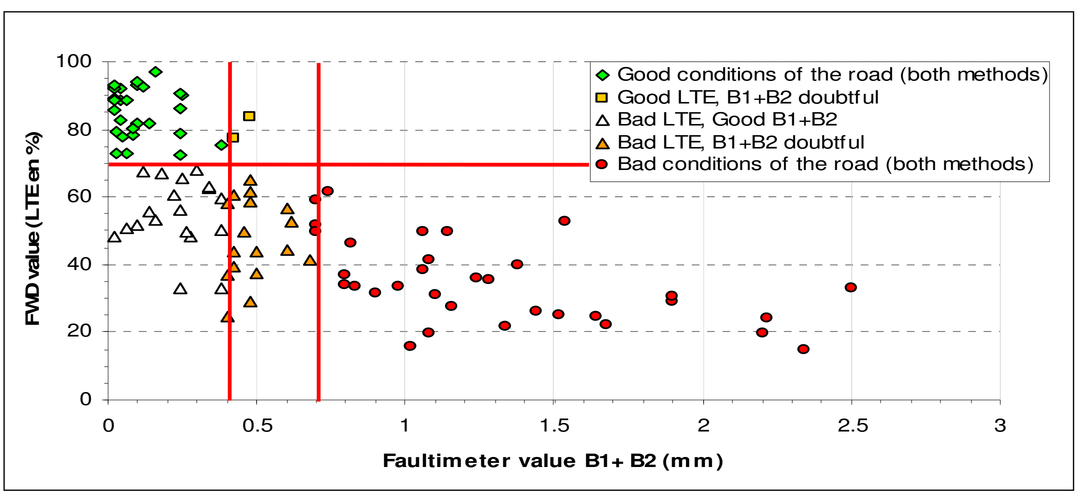

Figure 3 – Comparison between the FWD values and the faultimeter values

In other research projects where the FWD has been used, it was possible to define many characteristics of the behavior of the concrete slabs pavement. For example, it was possible to study this behavior under extreme environmental conditions and for different types of applications [Vanelstraete et al., 2009] [Perez et al., 2009].

Three factors influencing the results of the measurements of the FWD near slab joints have been studied: the force of the impact generated by the falling weight of the FWD, rain and temperature. Figure 4 illustrates the influence of the force on FWD maximum deflection near a joint. Whereas usually the resulting deflection varies in a linear way with an increase of the applied force, the graph clearly shows a “kink” in the line around a force of 60 kN.

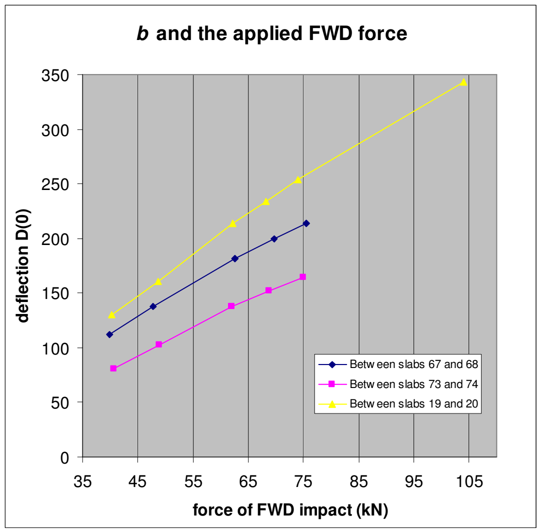

Figure 4 – Influence of the force on FWD maximum deflection near a joint

The surface temperature is an important factor of influence during the measurements with Faultimeter and FWD. In the case of both equipments measurements the results for surface temperatures higher than 15°C are very different from the results at lower surface temperatures.

Rain is another factor that influences the results of FWD and Faultimeter measurement results. From the available data of the FWD, we observed that:

- excellent values for LTE or DIF do not change much by rain;
- there is a tendency of higher LTE and lower DIF value at the beginning of rain fall;
- the LTE is lower and DIF is higher after rain.

The LTE and the b indicator are very useful complementary data given by the FWD. We could link the b indicator to the DIF indicator and the faultimeter value. In that way, a first approach was made to conclude that the presence of voids and the slab’s relative vertical movement at the joints can be related confirming earlier investigations [Van Geem & De Myttenaere, 2009]. We found that these equipments seem to be able to detect the presence of a void but further research, including physical inspections, may be necessary to prove their correctness.

Also in the case of the concrete slabs pavement, the FWD was able to monitor variations of the slabs behavior when they are broken and compacted in order to apply bituminous overlays.

In the case of the continuously reinforced concrete pavement, many calculations were made successfully using different computational tools (DimMET and Alize-LCPC). Both tools seem to be suitable to give a good overview of the slab behavior at the joints and the bearing capacity of the rigid pavement structures.

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