ROADS:

Constructions under increasing loads

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During this century enormous developments have taken place in the field of road transport. The number of cars and the magnitudes of the loads passing our road network has grown beyond expectation.

In September and October 1908 e.g., traffic counts were held for the first time in the Netherlands on 85 roads. Per day the total number of cars on all roads was 510. The surveyors also counted 10370 horse pulled wagons and 23630 bicycles. In other words, the mean number of cars per road per day amounted to an astonishing number of 6. Nowadays, 87 years later, the number of cars per day on one of the busiest highways in the Netherlands equals 85000.

In those early days, paved roads had a surface layer consisting of bricks which where placed by paviors. Nowadays asphalt paving is an industrial process in which plants are used having a production of 300 tons/hour.

Of course also tremendous developments have taken place in the field of pavement design and the characterisation of pavement materials. Until the early sixties only experience based methods were used in the Netherlands for the design of pavements. Nowadays application of multi layer linear elastic theory has become every days practice. Pavement materials like soils, unbound aggregates and asphaltic mixes are however complex materials which exhibit a non linear stress dependent visco-elasto-plastic behaviour. Linear elasticity is therefore only a crude simplification of reality. Nevertheless this approach has resulted in a fair understanding of the factors causing pavement deterioration and in general, in good quality pavement networks.

However, fast increasing loads, the needs to use recycled materials and strong limitations set on the budget available to build and maintain road infrastructure, are amongst others the main reasons to intensify pavement research. This research should result in improved material models and mathematical tools which allow pavement response and performance to be predicted more accurately then currently is the case. This knowledge should ultimately result in pavements which can be built more cost effectively (longer lives at lower costs).

The Road and Railroad Research Laboratory of the Faculty of Civil Engineering of the Delft University of Technology has been active in applied and fundamental research related to pavement materials and pavement design for a few decades.

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Some of this work has been done in close co-operation with the Structural Mechanics group and the Material Science group of the Civil Engineering Faculty. Other projects have been done in co-operation and under contract with the Road and Hydraulics Engineering Department of the Ministry of Transport and the Centre for Research and Contract Standardisation in Civil and Traffic Engineering – the Netherlands (C.R.O.W).
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At the moment research is concentrated on characterisation of the behaviour of asphalt mixes and modelling of pavement response and performance. As an example of the work that is currently going on, four articles are published in this issue of Heron each describing a particular field of research.

In the first article by the De Bondt and Scarpas a finite element simulation of the reflective cracking problem in pavements is described.Reflective cracking of thin overlays is a major problem, especially on farm to market roads on weak subsoils which are loaded by heavy agricultural traffic. A popular maintenance treatment is the application of reinforcements in the asphalt overlay. The described simulations allow proper modelling of the behaviour of reinforced overlays and is therefore an important tool in optimising maintenance strategies.

In the second article by Huurman attention is paid to the modelling of the development of permanent deformation in concrete block pavements. This pavement type comprises about 35% of the paved area in the Netherlands; its major defects are rutting and roughness. Good understanding of how these defects develop is essential in arriving to optimised designs and improved construction techniques. The article is based on a proper characterisation of unbound materials by means of repeated load triaxial tests and finite element modelling.

In the third article, Erkens and Moraal show that application of visco-elastic fracture mechanics to describe damage propagation in asphalt mixes, allows to predict the fatigue characteristics of asphalt mixes using fairly simple tests. This important result allows for the first time to set specifications for the resistance of asphalt mixes to fatigue in a way which can be adopted easily by practice. The approach has been used in setting specifications for polymer modified mixes for pavements on Schiphol Airport Amsterdam, as well as for the characterisation of the fatigue resistance of asphaltic base course mixes of some test pavements of the SHRP-NL (Strategic Highway Research Program – the Netherlands) research program.

The article by Hopman describes the linear visco-elastic multi-layer program VEROAD.
The development of this program is a major step forward in modelling the response of flexible pavements. This approach allows prediction of fatigue damage using either a dissipated energy approach or an approach based on maximum strains, as well as the development of permanent deformation.

It is believed these articles will be useful for researchers and practitioners working in the pavement engineering field. The interested readers are invited to address their request for additional information directly to the authors.