International Co-Operation On Infrastructure And Heavy Freight Vehicles Within OECD

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ABSTRACT

In the twenty-five OECD Member countries, policy priority on the infrastructure/heavy vehicle interaction issue is a result of the significant growth in road freight traffic and heavy trucks. At the same time, ageing and decaying highway pavements and the associated budgetary implications call for strategic research as well as for the development and application of innovative technologies.

A major goal of road transport policy for OECD Member countries is to find a balance between vehicle weight limits, vehicle performance and road wear while preserving the environment. Against this background, there is an urgent need to develop the road-friendliness of heavy freight vehicles and to obtain evidence of the magnitude of the effects of dynamic wheel loading on pavement distress.

INTRODUCTION

The Organisation for Economic Co-operation and Development (OECD), established in 1960, is an intergovernmental organisation of 25 democratic Member countries*, comprising over 150 committees dealing with a large spectrum of technical and policy issues from Economics to Agriculture through Environment and Science and Technology. The OECD aims and responsibilities are to:

- achieve the highest sustainable economic growth and employment;
- promote economic and social welfare throughout the OECD region by co-ordinating policies of its Member countries; and
- stimulate and harmonise the efforts of Member countries in favour of developing countries.

Its main tasks can be summarized as follows:

- assessing Member countries key policy issues and monitoring trends;
- facilitating discussions among countries and searching for common solutions;
- collecting and analysing comparative data;
- co-ordinating and harmonising national policies.

In accordance with these general objectives, the OECD Road Transport Research Programme (RTR) provides OECD Governments with scientific assessments as a support for policy and decision making.

In view of the economic importance of highway infrastructure, the mission of the RTR Programme has been heavily concerned with pavement (and bridge) research with the aim to better understand the mechanisms involved in the process of pavement deterioration under heavy vehicle loads, to better assess the performance of new or improved road structures and materials, and to find ways to mitigate the road impacts and nuisance on the environment.

The need to improve performance of both heavy freight vehicles and road infrastructure — and to implement appropriate road transport policy measures aimed at reducing road costs while increasing productivity — calls for better scientific knowledge.

A UNIQUE CO-OPERATIVE RESEARCH STRUCTURE

Since over 25 years, the thrust of the OECD RTR Programme has been to spur R & D through active co-operation and involvement of the most knowledgeable experts from worldwide leading institutes in areas of key interest. This international network has forged an authoritative partnership based on the assurance of mutual gains. This efficient organisation made it possible to:

- enhance effective and innovative research;
- undertake joint policy analyses and prepare technology reviews of critical road transport issues;
- pursue further worldwide exchange of scientific and technical information and promote road technology transfer between and within OECD Member countries and non-member countries;

thus providing the groundwork for shaping policy options on road infrastructure and road transport issues.

* Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.
The Commission of the European Communities also participates in the work of the Organisation.

A KEY RESEARCH AREA -- PAVEMENT PERFORMANCE AND HEAVY FREIGHT VEHICLES

The originating philosophy of the RTR Programme has allowed high quality realisation in terms of research analyses, state-of-the-art reports, technology reviews and international experiments in the field of pavement performance and heavy freight vehicle loading (Table 1).

FULL-SCALE PAVEMENT TESTING

As early as 1970, the RTR Programme focus was on research and technology assessments of the structural performance of road pavements under heavy vehicle loads. Back in 1983/84, the RTR Programme carried out, under the leadership of Switzerland, a joint project at the Nardò test facility (Italy) — involving research teams from 10 countries — to compare and evaluate the various methods for measuring strains in asphalt layers. The experts of the

Table 1. OECD pavement and bridge research studies

Year of publication	STUDY TITLE	Chairman	FOCUS OF STUDY					
			Research method	Vehicle effects	Climatic effects	Techniques, materials	Evaluation & condition rating	Strategies
1972	Accelerated methods of life testing pavement	Germany	x					
1973	Water in roads - Methods for determining soil moisture content and pore water tension	France, Germany	x		x			
	- Prediction of moisture content of road subgrades	Spain	x		x			
1973	Maintenance of rural roads	France					x	x
1975	Resistance of flexible pavements to plastic deformation	Spain		x	x	x		
1976	Road strengthening	UK					x	x
1978	Maintenance techniques for road surfacings	France				x	x	x
1978	Catalogue of road surface deficiencies	France					x	
1981	Bridge maintenance	France				x		x
1983	Impacts of heavy freight vehicles	France	x	x				x
1983	Bridge rehabilitation and strengthening	France		x	x		x	x
1984	Road surface characteristics: their interaction and their optimisation	Belgium		(x)	(x)	x	x	x
1984	Road binders and energy savings	France				x		
1985	Full scale pavement tests	Switzerland	x				x	
1986	Freight vehicle overloading and load measurements	UK		x				
1987	The maintenance of unpaved roads in developing countries	Belgium			x	x	x	x
1987	Pavement management systems	Denmark						x
1988	Heavy trucks, climate and pavement damage	Belgium	x	x	x	x	x	x
1989	Durability of concrete road bridges	Denmark	x				x	
1989	Traffic management & safety at highway work zones	France		x			x	x
1990	Road monitoring maintenance management: Manual for developing countries and damage catalogue (2 volumes)	Norway					x	x
1991	OECD Full-scale pavement test (FORCE Project)	Switzerland	x	x	x	x	x	(x)
1992	FORCE Project -- Concluding Conference	France	x	x	x	x	x	(x)
1992	Dynamic loading of pavements	Australia	x	x			x	x
1992	Bridge management	Netherlands					x	x
1993	Road strengthening in Central and East European countries	Germany		x		x	x	x
1994	Road maintenance and rehabilitation: funding and allocation strategies	World Bank, Finland					x	x
1994	Road maintenance management systems in developing countries	France						x
1994-96	DIVINE Project	Denmark, Australia, UK	x	x		x		x
1995/96	Recycling technologies	United States				x		x
1995/96	Performance indicators	World Bank					x	x

OECD Research Group in charge provided a review report on full-scale pavement testing (1) based on the experience gained during the Nardò test and published, under the responsibility of the Swiss Federal Office of Roads, in 1985 a more detailed technical report on the results obtained (2). This first experiment allowed to effectively address the issues raised by information exchange and technology transfer at an international level.

Because such large scale co-operation is beneficial to the international scientific community while keeping research costs at a low level for countries involved, it was decided in 1988 to launch a full-scale accelerated pavement testing using three types of pavement structures (two flexible and one semi-rigid) and two different axle loads [10 t and 11.5 t (the European Union standard)]. This experiment — known as the *FORCE Project* — aimed at identifying potential savings in pavement construction and maintenance, harmonising regulations regarding heavy freight vehicles, and improving the efficiency of international scientific co-operation approaches. 14 OECD Member countries and the European Commission were involved. With a budget of 650 000 US$, 4.5 million loadings applied, and over 60 million data processed, the 1989/90 *FORCE Project* has proven that international research co-operation was not only feasible but valuable to develop a tie between theory and laboratory testing and to better understand road pavement behaviour under the effect of traffic (3, 4). One of the most powerful full-scale testing facilities was used, i.e. that of the Laboratoire Central des Ponts et Chaussées (LCPC, France) in Nantes. The comparison of the three pavement structures [i) flexible thin: 6cm bituminous layer and 30cm unbound granular subbase; ii) flexible thick: 12cm bituminous layer and 30cm unbound granular subbase; and iii) semi-rigid: 6cm bituminous layer and 18cm cement-treated subbase] under 10 and 11.5 tonne axle loads shows that the 4th power law derived from the AASHO test of the 1950's constitutes only a general description and approximation of the relative damaging power of axle loads. In fact, wide variations of this general rule were found with powers from 2 to 9 depending on the degree of pavement deterioration, the criterion used for comparison and the condition of the pavement at the very moment comparisons were made. Only flexible pavements are covered by this conclusion since the semi-rigid pavement structure did not deteriorate at a sufficient level to allow for such comparisons.

DYNAMIC LOADING EFFECTS

In 1992, the OECD Group of experts on *Dynamic loading of pavement* (5) provided a scientific review of the causes and effects of vehicle wheel loads on pavements and bridges highlighting the importance of dynamic impact of heavy vehicles. It was felt essential to obtain evidence of the magnitude of the effects of dynamic wheel loading on pavement distress to improve productivity and reduce road costs.

A large scale 3 million US$ — one half common budget and one half national support financing — Research Programme on *Dynamic Interaction between Heavy Freight Vehicles and Infrastructure* (*DIVINE* Project) was therefore initiated in early 1994. It is based on long standing experience of OECD in this sector. The rationale of this Project can be found in the recommendations set forth in this 1992 OECD research report (5).

Because innovation can only start with careful analysis, the main purpose of initiating the DIVINE Project was to:

- evaluate **the effects of both conventional and "road friendly" suspension systems** on road wear;
- compare the test results using vehicles in typical operating conditions and under controlled laboratory conditions as well as through the help of computer simulation models:
- check the existence/incidence of dynamic wheel load spatial distribution on pavement performance and life; and
- assess the effects of dynamic loading on bridges of certain span ranges.

This two-year co-operative project is unique in scope and nature.

It covers a full range of research and is subdivided into six Research Elements:

- accelerated dynamic pavement testing
- pavement primary response testing
- road simulator testing
- testing of road computer simulation models
- spatial repeatability testing
- dynamic bridge testing.

It adopts an interdisciplinary approach where vehicle, pavement and bridge, as well as transport policy experts from both the private and public sectors are joining forces.

It calls for outstanding expertise and open-minded attitudes to face the diversity and complexity of the problems under review.

It implies concomitant running of experiments — although separated by long distances (over the three OECD regions (Australasia, North America and Europe) — with a well-functioning interactive structure.

It requests a high degree of involvement on the part of some 200 researchers and engineers as well as their strong dedication to the success of the Project.

AN INTERNATIONAL VENTURE

FUNDING ARRANGEMENTS

The core budget needed to run this vast research programme amounts to 1.5 million US$ funded by many OECD nations as well as vehicle and pavement industry and supported by at least as much contributions in kind (see Table 2).

INTERCONTINENTAL SPREAD

The following implementation details highlight the DIVINE Project international scope:

- **Research Element 1 -- Accelerated dynamic pavement testing**, is carried out at the CAPTIF accelerated pavement test facility at the University of Canterbury in New Zealand. It involves the New Zealand test personnel, the Research Leader from Finland and the Pavement Designer from US, Dr P. Sweatman (Australia) acting as co-ordinator at the local level.

Table 2 An international funding

Joint Funding	Industry Funding	In-Kind Contributions
Australia	Vehicle Industry & Road Construction	Public & private institutions
Austria		
Canada		NRC
Denmark		
Finland		
France	USAP	VECTRA THERMOCOAX LEEM
Germany		University of Hanover, BVM & PBW
Hungary		KTI
Japan		
Netherlands		
New Zealand		Transit NZ
Norway		
Sweden	SCANIA VOLVO	Public & private institutions
Switzerland		EMPA
United Kingdom		
United States		FHWA

- **Research Element 2 -- Pavement primary response testing**, involves test sections located in United Kingdom, United States and Finland and instrumented vehicles from Canada, United Kingdom and United States. The Research Leader is from the United States.
- **Research Element 3 -- Road simulator testing**, is carried out using the National Research Council of Canada shaker facility with test vehicles from Canada, the United Kingdom and the United States. The Canadian Research Leader supervises the planning, co-ordination and conduct of the research. The Hungarian team and the University of Hanover, Germany, are involved in data analysis.
- **Research Element 4 -- Testing of road computer simulation models**, this project is conducted by TNO, Netherlands, using as a wide range as possible of computer simulation packages around the world.
- **Research Element 5 -- Spatial repeatability testing**, in addition to results obtained within the other Research Elements, two instrumented (WIM) sections under real traffic -- in France and the United Kingdom -- are used as well as the shaker table from the US Federal Highway Administration. The instrumented vehicles are provided by Canada and United Kingdom. Research Leadership is ensured by United Kingdom and France.
- **Research Element 6 -- Dynamic bridge loading testing**, the main test programme lasting 2 months, was conducted on some bridges with differing spans and frequencies in Switzerland using the 5-axle tractor-semi-trailer NRC test vehicle. In addition, a research on the incidence of dynamic wheel load on short span bridges is taking place in Australia. The Research Leader is Swiss.

AN EFFICIENT ORGANISATION STRUCTURE

The six Research Elements outlined above were developed by the Scientific Expert Group chaired by Dr P. Sweatman (Australia).

To ensure smooth running of the whole research programme, it was felt necessary to designate, in addition to the Scientific Expert Group, a Research Leader for each Research Element to co-ordinate with the Programme Manager (United Kingdom) who is responsible for securing that the overall project meets the plans and budgets set by the Scientific Expert Group, and for assisting the Scientific Expert Group to ensure the scientific quality of the work done.

The co-operative research programme is overseen by an Executive Committee chaired by Mr J. Christensen (Denmark) and composed of high officials from some participating countries (Denmark, France, Netherlands, United Kingdom, United States), the Scientific Expert Group Chairman, the Programme Manager and the OECD Secretariat. Its role is to decide on strategic issues that could influence the outcome of the Research Programme, to secure sufficient funding, to encourage a widespread use of the knowledge acquired in drafting, for example, policy guidance to ensure that all findings would reach decision makers.

A summary of the organisation and management structure of the whole Research Programme is given in Table 3.

RESEARCH NETWORKING

To reduce distances, avoid delays and ensure fastest communication links, nearly all DIVINE Project participants are now using international e-mail (mainly the INTERNET network).

It is also worth noting that the needed interdisciplinary approach has created new exchange channels between the various professions involved i.e. from the road pavement engineer usually working for national instances to the vehicle researcher in private firms.

Needless to say that the DIVINE Project is not "static" in nature. Due to its intrinsic "dynamism" its membership extended recently to Hungary and other countries are expected to join in a near future.

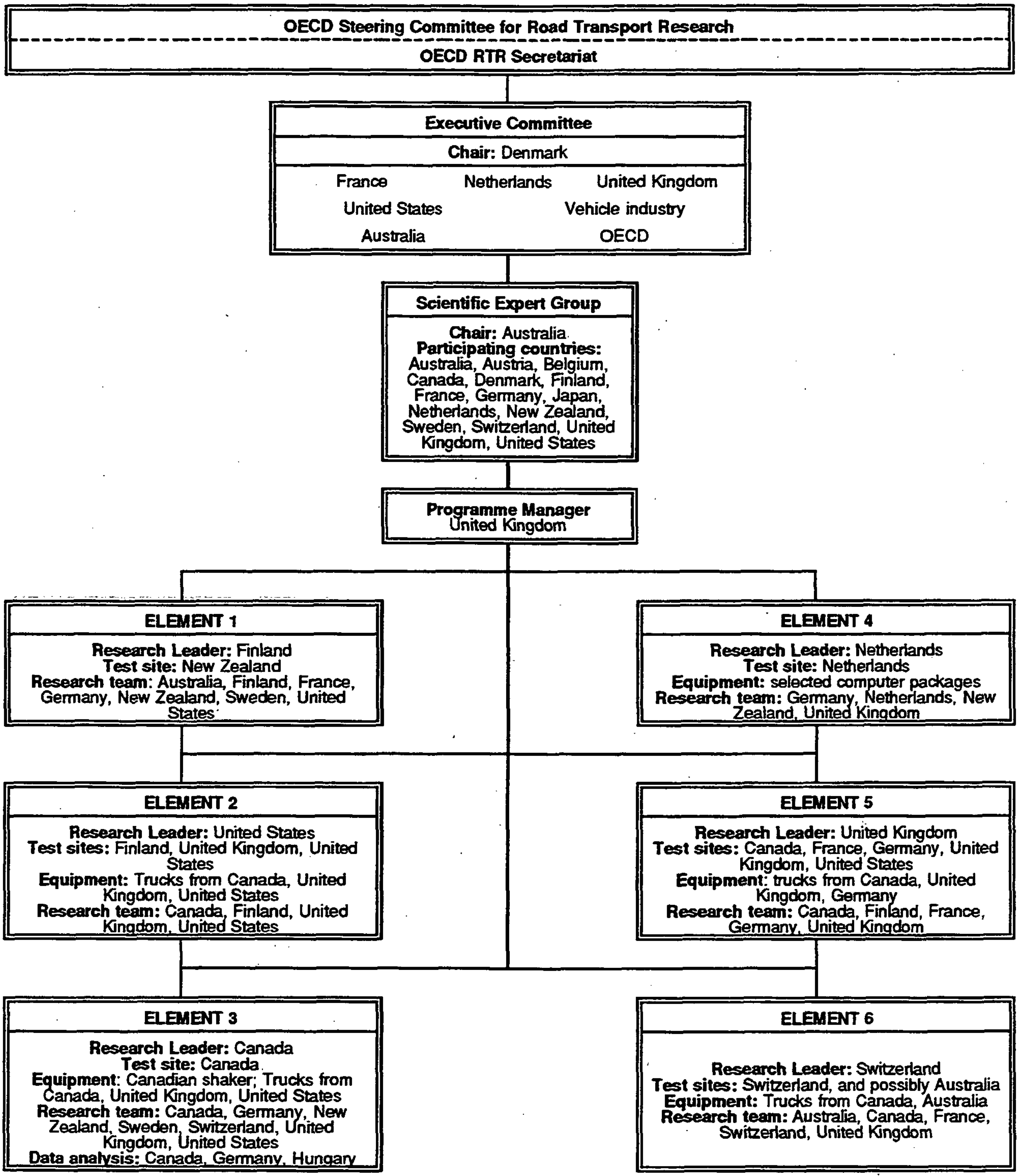
AN AMBITIOUS GOAL

Estimates of how much dynamic loads reduce the lives of pavements and assessments of the value associated with the use of road-friendly suspensions exist, however they never have been demonstrated experimentally.

This two-year co-operative research programme will mainly consist of empirical research with the aim, *inter alia*, of:

- assessing the effects of road friendly vehicle suspensions;
- reducing pavement deterioration;
- developing specifications for pavement strength and roughness;

Table 3 Management and organisation structure of the OECD DIVINE Programme



- evaluating the consequences of new vehicle technologies for bridges; and finally
- exploring the most effective ways to improve transport productivity by affecting dynamic loads.

The DIVINE Project should therefore provide the necessary foundation in terms of research and scientific knowledge to identify policy alternatives that would allow for the widespread introduction of road-friendly vehicle design in order to, ultimately, limit the costs of repair of the road network.

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