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Application of ALT method for the study of road pavements

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Summary

This paper presents a state-of –the –art of application of Accelerated Load Testing- ALT method for the study of road pavements.

ALT is defined as the application of wheel loads to specially constructed or in-service pavements to determine pavement response and performance under a controlled and accelerated accumulation of damage in a short period of time.

Over the years, more highway agencies have used accelerated load testing (ALT) as a means of evaluating potential construction materials, pavement designs, and other aspects of pavement performance. Various ALT techniques and principles are presented, and some recommendations of the use of each technique are finally given.

KEYWORDS: Accelerated Load Testing, structural design, pavement performance, pavement response

1. INTRODUCTION

Investment in road construction and maintenance in the world is at a very high level and any improvements will have a significant effect on the overall cost benefit analysis. An important way of analyzing road pavements or maintenance options before commencing the expensive process of road construction is Accelerated Load Testing (ALT), and this has been carried out at specially designed facilities in most European countries and in the world. Accelerated Load Testing (ALT) has been used for understanding pavement behavior for design and rehabilitation of pavements.

A comprehensive definition of what constitutes ALT, given by Metcalf [1] is as follows "…ALT is defined as the controlled application of a prototype wheel loading, at or above the appropriate legal load limit to a prototype or actual, layered, structural pavement system to determine pavement response and performance under a controlled, accelerated accumulation of damage in a compressed time period. The acceleration of damage is achieved by means of increased repetitions, modified loading conditions, and imposed climatic

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conditions, the use of thinner pavements with a decreased structural capacity and thus shorter design lives or a combination of these factors. Full-scale construction by conventional plant and processes is necessary so that real world conditions are modeled.”

2. ALT HISTORY

First ALT facilities in the world were introduced in 1912 in United Kingdom named “Road Machine” [2]. Then in United States in 1919 with the construction of the Arlington Test Road where concrete pavement designs were tested by loaded truck traffic.

Over time, facilities like the Bates experimental road, Maryland Test Road, and the Western Association of State Highway Officials Road Test began to test pavements using simulated or actual traffic on test roads [3]. While the aforementioned experiments paved the way for future ALT , the leader to modern ALT facilities was the American Association of State Highway Officials Road Test. This experiment began to elevate the rationality behind road construction and pavement design by developing empirical equations for design from the experiments results [4]. While ALT programs were developed globally over the next thirty years [5], ALT usage came to the forefront of pavement design in the 1990s [6]. In 1996, 28 APT experiments were located globally [7]; by 2002, this number had grown to 45, 14 being inside the United States [8].

3. TYPES OF ALT FACILITIES IN THE WORLD

Various types of APT exist in the world. The ALT facilities can be divided into full-scale systems and small-scale systems. Full-scale ALT facilities are those where a standard truck tire (Fig.1) is used for applying the loads to the pavement [e.g., the heavy vehicle simulator (HVS)], while small-scale systems are those where a scaled-down version of a truck tire and tire load is applied to the pavement (Fig. 2) [e.g., the model Mobile load Simulator (MLS)[8]. Full-scale ALT can again be divided into circular (Fig. 3) and linear (Fig. 4) tracking devices. The objective of ALT is to apply traffic loads and also environmental effects to a pavement at an accelerated rate compared with normal loading, and to determine the reaction of the pavement and its constitutive layers to this loading in a shorter time than would normally occur on a pavement under real traffic and environmental conditions. Acceleration of traffic loading is attained through the repeated loading by a set of truck tires over a short section of pavement, most frequently at increased loads. Through this process the response of the pavement can be quantified during a much shorter time than would be the case if a normal road was monitored under standard load applications.

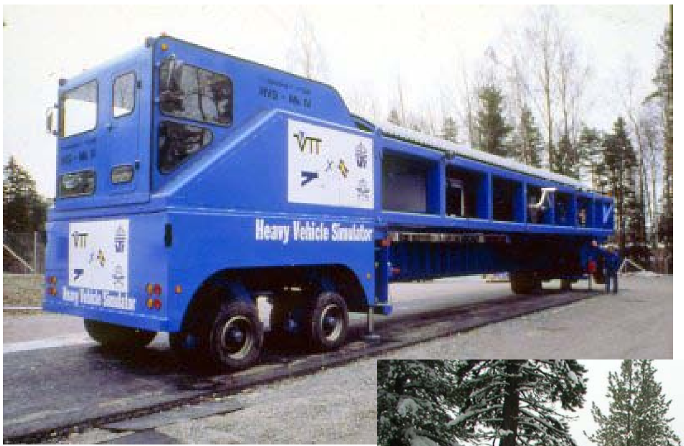

Fig. 1 Heavy Vehicle Simulator (HVS) [9]

Fig. 2 Mobile Load Simulator (MSL)[9]

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Fig. 3 Circular ALT facilities [9]

Fig. 4 Linear ALT Facility[9]

4. ALT FACILITIES IN EUROPE

First European ALT facility was built in United Kingdom in the year 1912. Then the number of ALT was growing (Fig. 5) and today in Europe are [10]:

- 10 full scale test tracks
- 2 pulse loading facilities
- Several small scale linear facilities

The Technical University of Iassy, Romania, commissioned a circular test track with a diameter of 10 m in 1957. After more than 40 pavements were tested, the loading machine was replaced in 1982 by a 15-m diameter circular facility. The facility was reconstructed again in 1999.

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Locations and ALT Facilities types are shown in Table1.

Table 1 ALT Facilities in Europe [10]

Crt.No.	Location	Type of facility
1	Lyngby, Denmark	Linear
2	Oulu, Finland	Linear (small-scale)
3	Delft, Netherlands	Linear
4	Sweden / Finland	Linear
5	Lausanne, Switzerland	Linear
6	Crowthorne, UK	Linear
7	Nottingham, UK	Linear (small-scale)
8	Madrid, Spain	Linear/Circular
9	Nantes, France	Circular
10	Iasi, Romania	Circular
11	Bratislava, Slovakia	Circular
12	Zürich, Switzerland	Circular
13	Bergisch Gladbach, Germany	Pulse Loading
14	Dresden, Germany	Pulse Loading

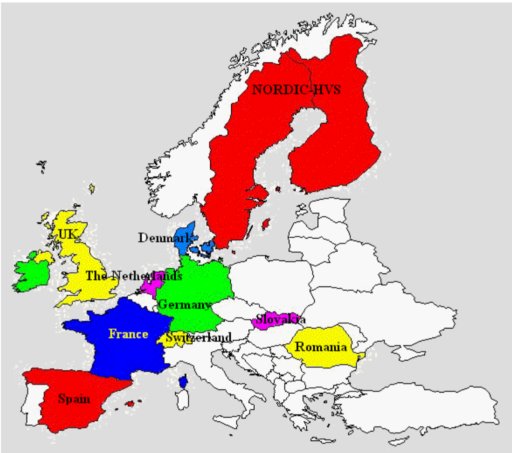

Fig. 5 ALT Facilities in Europe [10]

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5. DATA COLLECTED AT ALT FACILITIES

Collection and analysis of test-related data: load application, test section description, material characteristics, environment, pavement response, and pavement performance, is essential for developing the conclusions and recommendations. ALT data reported in the literature are divided into seven categories pertaining to the following elements [11]:

- Administrative
- Load application
- Pavement description
- Material characterization
- Environmental conditions
- Pavement response
- Pavement performance

6. BENEFITS OF ALT IN PAVEMENT EVALUATION

The process of ALT provides various benefits to pavement evaluation. The benefits[12] of using ALT for this purpose can be summarized as follows:

- Much quicker evaluation of the response from a selected preservation treatment (mostly structural response);
- The potential to compare a number of possible treatments with each other under similar conditions
- The potential to simulate the effects of the environment (typically heat–cold and wet–dry) on the response of the preservation treatment ;
- Specific pavement failure mechanisms can be caused on a test section before applying preservation techniques and the effect of various preservation options on these specific failure conditions evaluated;
- The effect of different loading parameters (i.e., load level or tire inflation pressure–tire contact stresses) on the response from the various pavement parameters can be obtained;
- A potential suite of preservation options can be applied to a similar 'failed' pavement and the responses from each of these evaluated and directly compared with each other in a relatively short space of time.

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7. DEVELOPMENT OF ALT TECHNIQUES IN THE FRAME OF COST ACTION 347 'IMPROVEMENTS IN PAVEMENT RESEARCH USING ACCELERATED LOAD TESTING'

The main objective of the Action was to develop a European code of good practice to optimise the use of Accelerated Load Testing ALT facilities and improve the application of results from these facilities. The technical results included an inventory over ALT facilities and research results obtained there, an evaluation regarding connections between and combined use of ALT and long-term pavement performance studies as well as a common code of good practice for the use of ALT facilities. The results obtained were well-received, and the network was a major success in establishing close links between ALT owners in most parts of the world.

The one topic of COST 347 with the most potential for making an impact on daily European ALT work was the development of a common code of good practice for the use of ALT equipment. The common code was built with a number of recommendations [10]: planning of experiment, test pavement, construction testing, loading, climate, data, pavement condition evaluation, pavement instrumentation, supplemental laboratory testing, operational safety, public hindrance and environmental protection, staffing, economy.

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