PROJECT PERIODIC REPORT

Grant Agreement number: 234303

Project acronym: SKIDSAFE

Project title: Enhanced Driver Safety due to Improved Skid Resistance

Funding Scheme:

Date of latest version of Annex I against which the assessment will be made:

Periodic report: 1st ☐ 2nd ☐ 3rd X

Period covered: April 2012-November 2013

Name, title and organisation of the scientific representative of the project's coordinator:

Prof. Dr. A. Scarpas, Technische Universiteit Delft

tel: +3115 278 4017

e-mail: A.Scarpas@TUDelft.NL

Project website address: www.skidsafe.org

Declaration by the scientific representative of the project coordinator

I, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate):

  X has fully achieved its objectives and technical goals for the period;

  ☐ has achieved most of its objectives and technical goals for the period with relatively minor deviations[1];

  ☐ has failed to achieve critical objectives and/or is not at all on schedule[2].

- The public website is up to date.
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 6) and if applicable with the certificate on financial statement.
- All beneficiaries, in particular non-profit public bodies, higher education establishments and research organisations, have declared to have verified their legal status. Any changes have been reported under section 5 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

[1] If either of these boxes is ticked, the report should reflect these and any remedial actions taken.

[2] If either of these boxes is ticked, the report should reflect these and any remedial actions taken.

Name of scientific representative of the Coordinator:

Dr. Athanasios Scarpas

Date: .20/ 01/ 2014.

Signature of scientific representative of the Coordinator:

.....

TABLE OF CONTENTS

1 Publishable summary

1.1 Summary description of the project objective

A key aspect of road safety is the provision of adequate friction between the tire and the road surface. Road conditions with low friction have been identified as a frequent cause of traffic accidents. Low friction between the road surface and the car tire can lead to vehicle skidding. A direct consequence of skidding is a dramatic loss of breaking power and steering capability of the vehicle which might lead to accidents and consequently to human casualties.

Skid resistance describes the contribution of the road surface to the development of friction at the tire-road interface. Friction originates primarily from the interaction of the asperities of the road surface with the morphological characteristics of the car tire. Unfortunately, due to the polishing effect of traffic combined with environmental factors, the tortuosity of the asperities gradually decreases and, as a consequence, skid resistance of the road surface drops and can reach unsafe levels.

There are many methods and devices to measure the skid resistance of road surfaces. The output of these devices is usually a measurement of friction under conditions specific to the particular device. In these cases, the influence of many factors affecting tire/road friction is not included. Furthermore, there are not direct correlations between the values obtained with the different devices.

In recent years, new computational techniques have been used to develop powerful algorithms which enable the simulation of interfacial contact phenomena. However, the majority of studies on tire/road interaction consider the pavement as a rigid body. In other cases, simplistic constitutive models are assumed. Moreover, in most studies, emphasis has been placed on the response of the tire and not the pavement. Yet, it is known that interfacial response is determined by the characteristics of both contacting bodies.

The FP7 SKIDSAFE project constitutes an attempt to examine at a more fundamental level the processes taking place at the interface between the pavement surface and the tire. The project aims at integrating state-of-the-art tire models with rolling contact algorithms, hydrodynamic algorithms for simulation of the effects of water and advanced constitutive models. These models will then be used to simulate the physical processes contributing to friction and wear in the interfacial zone between the pavement surface and the tire. The processes happening in the bulk body of the pavement structure as a result of friction will be also investigated. Furthermore, the parameters necessary for calibration of all components shall be obtained by extensive experimental studies.

The overall objective of SKIDSAFE is the development of a micro-mechanical, multi-physics computational tool for the prediction of the progressive loss of skid resistance as a function of the composition of the pavement surface and the deterioration of its characteristics with traffic loading.

Description of the work performed since the beginning of the project & main results

In the first phase of the SKIDSAFE project, the most crucial development was the design, manufacturing and calibration of a new Skid Resistance Interface Testing Device (SR-ITD). Since the inception of the project, this was deemed necessary since none of the available

testing devices provided objective experimental results for the interaction between rubber and the surface of a pavement. Tests with this device have been performed on various natural stone surfaces and various types of asphalt concrete mixtures.

The data collected were used for the development of friction constitutive models. These are utilized for micro-mechanical finite element simulations. The goal of the simulations was the identification of the relations between mix design and friction characteristics. Extensive mechanical tests have been performed for determination of the mechanical characteristics of the stone and the asphalt concrete materials. The mineralogical properties of typical European aggregates have also been measured experimentally and related to their mechanical characteristics.

Asphalt mix surface texture measurements have been performed to create realistic micro-mechanical finite element meshes. Novel algorithms have been developed for material parameter determination and simulation of the contact conditions between rubber and asphalt pavement surfaces.

The interrelation between asphalt mix design and the in time development of pavement surface skid resistance under various pavement surface moisture conditions was investigated by extensive field measurements on several European pavements.

In order to address the extreme case of skidding due to hydroplaning under wet conditions, an instrumented vehicle equipped to measure hydroplaning related quantities (like water film thickness and tire to road forces and moments) has been used to collect data necessary for calibration of finite element models for simulation of hydroplaning.

Pavement management tools for mix design, variable speed limits and optimal pavement maintenance strategies constitutes one of the main deliverables achieved by SKIDSAFE.

The consortium has also been active in dissemination activities. Several papers have been accepted in various venues and journals. Also, an international course on Mechanics of Tire-Pavement Interaction and three workshops have been organized. The course lecturers and workshop presenters were members of the SKIDSAFE consortium. Other international experts were also invited.

Expected final results and their potential impact and use

The SKIDSAFE project has a wide scientific scope ranging from fundamental experimental and modelling activities to large scale testing and material development. Besides this, two very different classes of materials are to be considered in the project: pavements and tires. It should be noted that for instance the production of highway pavements encompasses a wide range of stakeholders: multinational oil companies that modify and sell bitumen, companies that provide aggregates, micro-fillers and polymer modifiers for the bitumen, road consultant companies etc. The pavement industry, i.e. the industries that are responsible for the ultimate construction of roads, can be considered as ‘integrator’ operating at the end of the value chain.

This wide range of expected results, from models to large scale testing and the even wider range of stakeholders like aggregate producers, possible end users, universities, infrastructure management consultants, construction and maintenance companies, tire producers, local government bodies responsible for construction of roads and national road authorities responsible for traffic safety may profit from the expected contributions of SKIDSAFE to a decrease of traffic accidents due to loss of skid resistance. The overall impact areas of SKIDSAFE may be classified as follows and are also shown in Figure 1.

- Impact on road traffic:
    - Accidents decrease
        - Reduction of injuries and fatalities
        - Reduction of economic costs
        - Mobility increase.
- Pavement industry.
- Tires industry.
- Sustainability and environment:
    - Improvement of infrastructure management.
        - Reduced costs
        - Increase of process efficiency
- Impact in other industries.
    - Indicators for easy communication between private concessionaires and public administrations
- Knowledge increase.

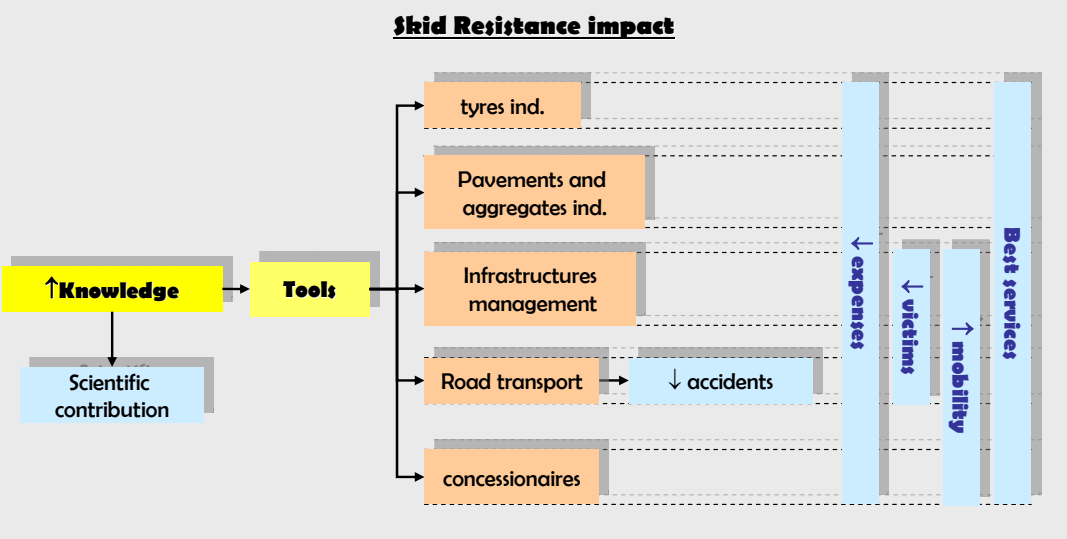

Figure 1 SKIDSAFE expected impact chart

At this point it must be noticed that, for a project of this complexity, only a multidisciplinary and multinational programme with sufficient start-up funding can achieve significant results. The SKIDSAFE consortium consists of highly qualified academic research groups and representatives from the stake holding industries that bring in their specific expertise. From the perspective of the industrial partners the collaboration with academic partners is very important because in the current situation of global competition, growth can only be assured by constant innovation towards high added value, knowledge intensive products.

In addition to the above, local government bodies responsible for construction of roads and national road authorities responsible for traffic safety can profit from the expected contributions of SKIDSAFE to a decrease of traffic accidents due to loss of skid resistance.

The project web site **www.skidsafe.org** is updated regularly with news about the project.