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Name and home country:

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Field of study: Highway construction and  
maintenance.

Country (ies) of study:

United Kingdom

FINAL REPORT  
ON THE STUDY IN THE UNITED KINGDOM  
FROM 5 OCTOBER 1972 to 7 APRIL 1973

R Raciborski  
(United Nations Fellow)



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## 1. INTRODUCTION

My study in the United Kingdom has been arranged by the Technical Assistance Office of the United Nations and was initially intended to cover the period from 3 November 1972 to 3 March 1973. In fact it has been extended to six months from 5 October 1972 to 7 April 1973 including a one month course of English Language. The main part of my study took place in Materials Division of the Transport and Road Research Laboratory, Crowthorne, Berkshire, England.

## 2. A STATEMENT OF QUALIFICATIONS TRAINING, RESPONSIBILITIES AND THE NATURE OF MY WORK IN POLAND

Before receiving the Fellowship award, I worked at the Road Research Centre in Warsaw as a Senior Engineer in Road Materials Division. Earlier I qualified from the Warsaw Technical University with a degree in Civil Engineering in 1965. Subsequently I worked at the Road Construction and Maintenance Unit as a site Engineer for over 3 years. Since 1969 I have been employed by the Road Research Centre in Warsaw and have been concerned with the investigation of road materials. With a background of general experience in road construction and road materials I began to specialise in bituminous binders and fillers. More recently I was engaged in an investigation of the bitumen and filler mixtures with a view to providing a basis for new standard on fillers used in asphalt mixtures. I have also taken part in several projects concerned with the development of methods of road construction in Poland. My chief interest and responsibilities are concerned with the implementation of modern techniques in the construction of road surfacings.

## 3. THE INTENDED PROGRAMME OF MY STUDY IN THE UK

Road traffic has increased considerably in Poland over the last few years and a further increase is expected in the next few years. More and more vehicles, especially passenger cars, are produced every year in Poland and it is assumed that the present number of road vehicles will double in 4 or 5 years. This situation has created an urgent need for quick modernisation of roads to keep pace with the intensified traffic. It has also created a need for the enlargement of the existing road network including the construction of many new roads and motorways. My reason for choosing Great Britain for my Fellowship study is that this country is far advanced in the field of road construction.



I had hoped that my knowledge and experience will be enriched particularly by being able to work at the Transport and Road Research Laboratory which is renowned for its leading position in the field of pavement construction in general and in the recognition of the role of the environment in particular. It was intended that the programme of my study should include the following points:

- a) methods of testing and evaluation of road materials, particularly bitumen, fillers, aggregates and mixes.
- b) factors affecting the quality of road materials.
- c) methods and criteria for quality control of bitumen mixes.
- d) various aspects of modern methods of design, construction and maintenance of bituminous pavements.
- e) road safety and environmental problems connected with roads and transport.

My chief object was to assess the current trends in road technology as far as they concern bituminous pavements for roads, especially motorways, with particular reference to the following:

- a) to deal with some environmental difficulties common to many countries, caused by the rapidly increasing road traffic,
- b) to assist in the solution of some standardisation problems in road pavement technology.

#### 4. THE PROGRAMME OF STUDY AS ARRANGED BY THE UNITED NATIONS AND BRITISH COUNCIL

In the first month of the Fellowship I attended a general English course in the London School of English. It was a full-time course of 28 hours a week. On the completion of this course I was able to communicate with English people and travel in the country without any difficulty. For the next 5 months I studied at the Transport and Road Research Laboratory, 'Crowthorne, where I had been accepted through the British Council as a voluntary worker. I was attached to Materials Division in the Highways Department. This Department is concerned with research into problems of construction and maintenance of roads. The work of Materials Division is concerned chiefly with the properties of roadstone, bitumen, tar, cement, polymers, resins, waste materials, the performance of these materials, the skidding resistance of road surface, road markings and specifications for road materials.

The main part of my work in Materials Division was concerned with factors affecting the resistance of skidding of road surfacings. I have carried out a detailed study of factors affecting the resistance to skidding of the surfacing on motorway M1 in England with particular reference to the effect of traffic.



A paper on this subject may be issued by TRRL in the next few months and it will summarise factors influencing the resistance to skidding of road surface in an attempt to define the role which traffic plays in the changes of the slipperiness of bituminous surfacings. In line with other TRRL work already published it was found that there was a good correlation between the volume of commercial traffic on the motorway and the measured sideways-force coefficient, the latter decreasing by approximately 0.01 units when the number of commercial vehicles increased by 150 - 200. It is concluded that a better correlation could be achieved if it were possible to estimate with greater precision the damaging effect of traffic on road surfacing. At the end of that paper a short comment is given on the proposed new standards of resistance to skidding in the United Kingdom.

As the high resistance to skidding is an important requirement for road safety, large amount of effort is spent on this problem in the Laboratory. It has been found that raising the level of resistance to skidding of the surfacing considerably reduces road accidents. Various methods of anti-skid treatments have been developed. The effect of these treatments is usually measured by changes in the skidding rate, which is the percentage of personal injury accidents involving skidding. Several fullscale experiments have been carried out to investigate this problem. I have studied most of the reports on this subject. The selection of appropriate component materials for anti-skid surfacings is the most important step in providing good resistance to skidding. I have had the opportunity to become acquainted with the characteristics and methods of test of some of these materials as well as with the equipment used for testing.

With regard to road binders it has been established that binders which were relatively susceptible to weathering (light, radiation, water) could significantly extent the effective life of a surfacing at a satisfactory level of resistance to skidding. It was found that some refined bitumens performed better than others and that some modified bitumens have shown a markedly improved performance. Laboratory work is still continuing with the object of developing tests which could be used to select bitumens with the desirable weathering properties. The tests used at present are both physical and chemical. To measure the changes in the physical properties of the bitumens a weatherometer is used in which the binders in the form of thin films are exposed to ultra-violet radiation in the presence of air and water. The changes in the chemical constitution of the bitumens are assessed by solvent fractionation, molecular weight measurements, elemental analysis and infra-red spectroscopy. The results of these tests are currently being correlated with the road performance of the bitumens.



The road performance is investigated by means of the so called core technique developed by the Laboratory. The basic concept of this method is that small cores of road asphalt are inserted into the pavement of a heavily trafficked road and the changes in the texture of the material are followed.

To achieve a sufficiently high degree of friction between the tyres of vehicles and the road it is necessary to use aggregate which is resistant to polishing under traffic, and at the same time resistant to crushing and abrasion. Details of the methods of test and the criteria used in the evaluation of roadstones were made available to me. I became acquainted with laboratory equipment used in these tests and also with new kinds of synthetic aggregates of very high resistance to polishing which have been used in non skid surfacings.

There are two basic types of surfacing used in the United Kingdom, characterised by a deep-textured, non-skid surface. The first is a standard rolled-asphalt wearing course applied to most motorways and main roads. It has been used in this country for decades with satisfactory results. Although in certain cases its resistance to plastic deformation is not very high it has proved to be very durable and still some modifications of the mix design are being explored to improve the performance. This gap-graded mixture of the various proportions of binders, fillers, sand and coarse aggregate is relatively tolerant to composition variations and to the laying conditions. Its comparatively high resistance to skidding is due to a surface layer of precoated chippings which are rolled in while the material is still hot. With a heavy application of good quality chippings the resistance to skidding is practically independent of the weathering characteristics of binder in the asphalt. There are experiments in progress with a view to assessing the performance of different types of surfacing and so far the results show that the change in the resistance to skidding with speed of vehicles is generally less on rolled asphalt surfacing than on surfacings such as asphaltic concrete or mastic asphalt common in most European countries.

The second basic type of surfacing used in the United Kingdom is known as surface dressing. This can be laid on different types of substrate with quite good results. It provides rapid and relatively cheap method of renewing the resistance to skidding of worn surfacings. Road experiments have proved that it can be used successfully on nearly all classes of bituminous roads. The strength of the bond between the substrate and the applied chippings is contributed entirely by the binder. Under very heavy traffic and at high speeds the bond provided by most refinery bitumens may not be sufficiently strong and methods of modifying the binder to obtain maximum adhesion of the chippings are being investigated. The most common additives used in cut-back bitumen and road tar were natural rubber and synthetic polymers. It is suggested that binders modified by addition of an epoxy resin and fillers should be investigated.



Unmodified cut-back bitumens and tar are the most widely used binders at the present moment.

Side by side with the problem of resistance to skidding which concerns safety the aim of research is also to develop the most durable pavements. This needs both good quality material and modern manufacturing and laying techniques. Investigations are in progress on a fully automatic operation of an asphalt plant fitted with sampling and testing system for the control of aggregate grading, temperature, cold aggregate and filler feed, allowing for moisture content and for changes in the viscosity of the binder. Such a system of control should optimise the overall process and minimise variability of the material. Other investigations are concerned with the improved methods of compaction of bituminous mixtures.

During my study I have had the opportunity to become acquainted with some of the problems connected with the construction of bituminous pavements on motorways. I was able to inspect a large part of the motorway network in Great Britain, including some of those under construction. I was able also to make observations concerned with maintenance operations on motorways.

Generally road construction can be classified into two broad groups, flexible and concrete. Both these types are designed on the basis of recommendations derived from the result of fullscale road experiments during the last 15 years and aim to provide pavements that will last for at least 20 years without serious repair. Both these forms of construction are currently used on British motorways. It was common practice in the past to invite tenders for both flexible and concrete construction, and the choice was made on the basis of initial cost without taking into account differences in subsequent maintenance and operating costs. TRRL have found that there can be significant differences in maintenance costs and the ultimate life between the two types of construction. Flexible construction is cheaper over the first 15-20 years but there-after maintenance costs increase and over the period of 50 years the costs of maintaining concrete roads and of the traffic delay are less than those of flexible construction. These differences are naturally sensitive to changes in the discount rate and can be significantly influenced by actual economic system. It is generally estimated anyway that the asphalt surfacing unit costs are lower than the concrete one and this concerns especially motorways presumably because of the very large scale of work.

Maintenance operations on British motorways cover in general strengthening of the pavement structure to restore loss of strength due to cracking or to restore loss of riding qualities due to deformation, surface treatment to restore loss of resistance to skidding, renewal of motorway markings, resurfacing the hard shoulder, raising kerbs, local patching etc. Concrete pavements may also require resealing the joints. There is usually little need for regular winter maintenance during the winter periods because snow and ice are not very frequent features in this country.



Criteria have been established in the United Kingdom for the assessment of maintenance needs on motorways and especially for the damaging power of traffic, minimum sideways force coefficient, texture depth and deformation limits. They are different for concrete and bituminous pavements. Most highway authorities already have an informal and simple rating system for maintenance needs and there are also suggestions for an official rating system covering all roads. This system falls into two parts: the field assessment and the processing in the office. The final ratings serve two purposes: they identify the most urgent items of work within each road section and also since they have taken into account differing traffic flows and type of roads, the most urgent item of work within the whole highway network.

Road safety and environmental problems are special responsibilities of the Department of the Environment and special measures are taken to prevent road accidents and to minimise environmental pollution at every construction and maintenance operation. Britain probably has the best maintained local roads in Europe especially in rural areas and large scale investigations have been carried out to minimise the damaging influence of increasing traffic on the environment even at a consequence of higher cost of construction and increasing mileage of roads.

I have also visited the Scottish Branch of the TRRL in Livingston, Scotland. This branch is engaged in investigations concerning problems particular to the climatic conditions in Northern Britain. One aspect of investigation in Scotland is the prevention of frost heave and frost damage in road construction. In this work the suitability of different materials for sub-bases and bases is being assessed and the frost susceptibility is measured using some new simulated tests developed for this purpose.

Finally I spent some time during my training carrying out comparative tests on bitumens using the equipment available at the TRRL. It is also of great importance to me to have established contact with many people at TRRL and I am looking forward to closer and more successful cooperation in the future and I can foresee the need for the exchange of technical experience in the subject considered.

##### 5. EXPECTED CONTRIBUTION OF MY TRAINING IN THE UK TO THE BENEFIT OF MY COUNTRY

I hope that my training in the United Kingdom should contribute to an improvement in road technology in Poland. The areas in which my enlarged experience should prove of particular importance are:

- a) material engineering including binders, roadstone and asphalt materials
- b) surface characteristics of bituminous pavements including the riding quality and especially the resistance to skidding.



- c) the design and maintenance of surfacings for heavily trafficked roads.
- d) the selection of the most suitable types of pavements for motorways
- e) standardisation and quality control of road materials

I expect that further advantages of my study will become apparent depending on the responsibilities and the nature of my work in the future. I hope that my study in Britain has been a worthwhile contribution to the United Nations Development Programme in Poland.

## 6. ACKNOWLEDGEMENTS

I would like to thank the United Nations Technical Assistance Office in Geneva, the British Council in London and in Warsaw for making possible for me to study in the United Kingdom and for taking care of all the necessary arrangements.

I am grateful to the staff of the Transport and Road Research Laboratory at Crowthorne, England with whom I have come in contact and who have shown me so much helpfulness and cooperation during my training.

Crowthorne

30 March 1973.