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ROAD LIGHTING FOR WET CONDITIONS

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PREFACE

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SUMMARY

The use of the luminance distribution on the dry road surface as a criterion of the quality of road lighting of traffic routes has gained acceptance in a number of countries. However, in rainy climates a road surface is moist or wet for a substantial part of the dark hours, during which time the lighting quality is reduced.

The aim of this report is to give information which facilitates the inclusion of the wet condition in the design of road lighting installations. The information, on one hand covers most aspects of road lighting for wet conditions, but, on the other hand, is mainly in the form of a collection of experience.

The information on the procurement of road reflection data in particular cannot be considered to be final, as research is still in progress and as a more comprehensive report on road reflection properties is planned by the CIE.

RESUME

L'utilisation de la distribution de la luminance sur la surface de la chaussée comme un critère de la qualité d'éclairage des artères de circulation s'est imposée dans plusieurs pays. Par un temps pluvieux, cependant, la surface de la chaussée est humide ou mouillée pendant une partie importante des heures noires, pendant lesquelles la qualité lumineuse est réduite.

Le but de ce rapport c'est de donner des informations qui facilitent l'inclusion des conditions mouillées dans le dessin d'installations d'éclairage de voies publiques. D'une part, l'information couvre presque tous les aspects de l'éclairage dans les conditions mouillées, mais d'autre part, l'information est principalement donnée sous forme d'une collection d'expériences.

L'information, en particulier sur la procuration de caractéristiques sur la réflexion de la route, ne doit pas être considérée comme étant finale, puisque la recherche est toujours en progrès et qu'un rapport plus compréhensif sur les propriétés de la réflexion de la route est plané être fait par la CIE.

ZUSAMMENFASSUNG

Die Anwendung der Leuchtdichte auf der Oberfläche der trockenen Strasse als ein Kriterium der Qualität der Strassenbeleuchtung für Verkehrsstrassen ist in einer Reihe von Ländern angenommen worden. In regnerischen Klimaten ist die Strassenoberfläche aber feucht oder nass in einem erheblichen Teil der dunklen Stunden, während welcher Periode die Beleuchtungsqualität reduziert ist.

Der Zweck dieses Berichtes besteht darin, Auskünfte zu erteilen, die die Einschliessung der nassen Bedingung in der Auslegung der Strassenbeleuchtungsinstallationen erleichtern. Die Auskünfte umfassen einerseits die meisten Aspekte der Strassenbeleuchtung für nasse Bedingungen, andererseits basieren sie hauptsächlich auf gesammelten Erfahrungen.

Die Auskünfte besonders über die Beschaffung der Daten der Strassenreflexion sind nicht als endgültig zu betrachten, da die Forschung noch Fortschritte macht, und da ein umfassenderer Bericht über die Wirkung der Strassenreflexion von der CIE geplant ist.

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1. INTRODUCTION

In CIE Publication No. 12 it is explained that the bright patch formed on the road by a single lantern has the shape of a letter T. When a surface becomes moist or wet, its reflection properties change in two respects. The "head" of the T-shaped patch becomes weaker, while the "tail" becomes stronger and longer.

When such changes occur, the juxtaposition of the bright patches in a road lighting installation will form a luminance pattern on the road with reduced uniformity. Mostly the overall uniformity decreases greatly, while the longitudinal uniformity is less affected.

The extent to which the road reflection properties are affected depends upon the road surface itself and upon the weather. The magnitude of the consequent change in the luminance pattern on the road depends upon the road lighting installation, its geometry and the lantern luminous intensity distribution.

In the extreme situation of a very specular wet surface, however, the luminance uniformities will always be poor. The road will be dark, except for longish, glaring reflections from the lanterns and also from headlights of opposing cars, traffic signals, windows and any other light sources in the vicinity of the road.

The reduction in luminance uniformity and the additional glare, which is often accompanied by a reduction in road friction and glare from scattering of light from the wet windscreen, constitutes a dangerous situation in night-time driving.

Therefore, efforts should be undertaken to maintain the performance of the lighting installation in wet weather, to the extent it is possible, both practically and economically. In accordance with sound economical principles these efforts should be geared to the frequency of moist and wet weather, i.e. according to the local climatic condition.

There are two lines of action in maintaining road lighting performance in wet weather. Firstly, to employ road surfaces with a more coarse texture, whose reflection properties are less sensitive to wetting. Secondly, to design the installation for a wet condition of the road surface, in addition

to the dry condition, thus securing control of the performance of the installation for a range of reflection properties.

It is realized that the coordination between the road surface and the lighting installation might present severe difficulties. The necessary cooperation between the road engineer and the lighting engineer is not traditional and, further, the road and the lighting installation often belong to different authorities or they are financed by different funds.

However, the lighting engineer should undertake the mission of influencing the choice of road surfaces, since a truly satisfactory result for wet conditions cannot be obtained, unless the road surface has acceptable reflection properties.

On the other hand, it is possible in most cases to improve the performance of the lighting installation in wet weather, without sacrificing the performance in dry weather. If the economy of the installation is considered, many things can be done by taking both situations into consideration in the planning stage.

It should be realized also that taking both the dry and the wet condition into consideration leads to a decrease in the sensitivity of installation performance to variations in road reflection properties caused by wear and age. This, it is believed, makes the luminance concept more reliable and thus more fitting as a basis for the design of road lighting installations.

As will be clear from the content of this report the 'wet condition of a road surface' is a rather difficult matter to describe. Considerable research has been carried out so far with this aim. This has resulted in a system for describing the characteristics of the wet road surface, as given in this report, applicable to road lighting design. Research, however, is still going on in this field, which may lead to improvements in the simplification of design procedures.

Considerable time will certainly be involved before such research can be considered to be finalised. As, furthermore, the wet condition of the road occurs during a considerable part of the dark hours in many countries, guidance on the design of lighting installations for the wet road cannot wait for the ultimate results of investigations on the reflection properties of the wet road surface and has therefore been given on the basis of the considerable amount of knowledge presently available.

2. PROCUREMENT OF ROAD REFLECTION DATA

2.1 General remarks

The planning of road lighting for wet conditions presumes that two r-tables, one for the dry and one for a certain wet condition of the road surface, are available. The two r-tables define on one hand the range of reflection properties, which is to be taken into account in the planning of the lighting installation and, on the other hand, they are a model of the reflection properties of the road surface.

For technical and economical reasons the range of reflection properties defined by the two r-tables cannot cover all reflection properties attained by the road surface at any time and in any weather situation. Rather the r-table for the dry condition should correspond to a typical lightness and degree of specularity of the worn surface, while the choice of the r-table for the wet condition should be based upon a deliberate exclusion of the most wet and specular conditions of the surface, as discussed in section 2.2.

The above-mentioned model can never be very accurate for a number of reasons. Firstly, the lighting installation is often planned before the road surface has been laid or before it has achieved a state of age and wear, which permits a realistic measurement of its reflection properties. Secondly, the reflection properties of a worn surface are subject to variations with wear and age. Finally, a road surface is generally repaired or renewed a number of times during the lifetime of a road lighting installation.

Although a great accuracy should not be attempted, when choosing the r-tables, these ought not to give a too erroneous picture of the true situation, since in that case the lighting installation will turn out to have a poor performance or to be too expensive.

The r-tables can result from measurement, provided the road surface already exists in a worn state and provided measuring equipment is available. The measuring equipment should comply with CIE Publication No. 30.

Very often measurements of the full r-table cannot be carried out, and for this situation provisional classifications of road reflection properties are given in section 2.5.

The standard r-tables of the classifications and their scale can be chosen on basis of the three parameters of the description method (also provisional), which is defined in section 2.4. The parameter values can be obtained from simplified measurements of Q0 and S1 for the dry and the wet condition.

Section 2.6 gives some guidance for choosing the standard r-tables and their scale from the description and the surface texture of the road surface.

These methods can be used when no measurements are available or they can supplement measurements that are not complete, e.g. because data for the wet condition is missing.

It is better to choose the data by a qualified judgement and thus design the installation for some wet conditions at least, instead of refraining from this in situations where the procedures seem to be very uncertain.

For the same reason it should be permissible to choose a standard r-table for the wet condition with a lower degree of specularity, when for economical or other reasons the true degree of specularity cannot be taken into account.

This discussion refers to the situation, where the road surface is the a priori unknown factor, for which r-tables are chosen on basis of measurements. This situation is not the ideal one (although it is often the case in practice), as the coordination between the road surface and the lighting installation is rendered difficult.

It is strongly advised that the reflection properties of road surfaces on major roads become governed by agreements or requirements, which permit road lighting of a good economy and performance and simultaneously permit a simplified, standardized use of r-tables.

Because of some special circumstances that apply for the wet condition, a standardized use of r-tables for the wet condition has been proposed in chapter 4. This standardization is essentially part of the standardization in the Danish road lighting codes, which covers both dry and wet conditions, and which is backed by a set of requirements for the road reflection properties. See Frederiksen and Sørensen (1976).

The introduction of standardizations like the above-mentioned does not eliminate the need for measurements of road reflection properties, but does

change the purpose of the measurements. Firstly, the standardizations and the requirements must be based on road reflection data and, secondly, measurements must currently be carried out in the implementation of the requirements.

2.2 Definition of the wet condition

2.2.1 Road reflection properties and road lighting performance in wet conditions

After rain, in the course of drying, the surface runs through a continuous range of wet conditions. This continuous range of wet conditions corresponds to a continuous range of reflection properties, each of these being characterized by a degree of specularity, which decreases steadily, until the road surface is completely dry.

Thus the lowest degree of specularity is the one attained in the dry condition, while the highest degree of specularity, which is found during or immediately after rain, depends both of the road surface and of the intensity of the rainfall. This is illustrated in fig. 1, in which the degree of specularity is plotted against the drying time for a number of road surfaces.

In practice, drying courses like those shown in fig. 1 are found after each rainfall, and further, more or less stable wet conditions are met during rain and humid weather. During the dark hours of a year, a certain degree of wetting and thus a certain degree of specularity of the road surface occurs a number of times, which amount to a fraction of the total dark hours. The distribution of duration by degree of specularity for a road sample exposed to the Danish climate is shown in fig. 2.

The luminance uniformities, which depend upon the degree of specularity of the road surface, and thus the performance of the lighting installation, are also subject to statistical variations. If the lighting installation is designed for the dry condition only and the rate of deterioration of the performance with wetting is high, the performance of the lighting

installation might well be poor in most wet conditions. If, on the other hand, the lighting installation is designed to have a certain performance in the dry condition and a poorer, but acceptable performance in one of the wet conditions, the performance will be acceptable for all conditions of less wetness than this wet condition.

Thus the duration, in which the lighting performance is under control, is extended to include parts of the wet periods.

The definition of the wet condition, which is used in the design stage, should be based upon a compromise between the wish to control the lighting performance for a large part of the working hours, and the economical and technical consequences. To this purpose diagrams giving the sum of durations of wet conditions are useful. Such a diagram, which is obtained from the distribution of durations in fig. 2, is shown in fig. 3.

The curve in fig. 3 establishes the connection between a laboratory definition of the wet condition, for which the degree of specularity is known, and the occurrence of wet conditions in practice, for the road surface in question and for given climatic conditions.

There should be diagrams for all commonly used road surfaces. Measurements of this type have, however, only been carried out in Denmark so far, see Sørensen and Nielsen (1974).

S1' (DEGREE OF SPECULARITY IN WET)

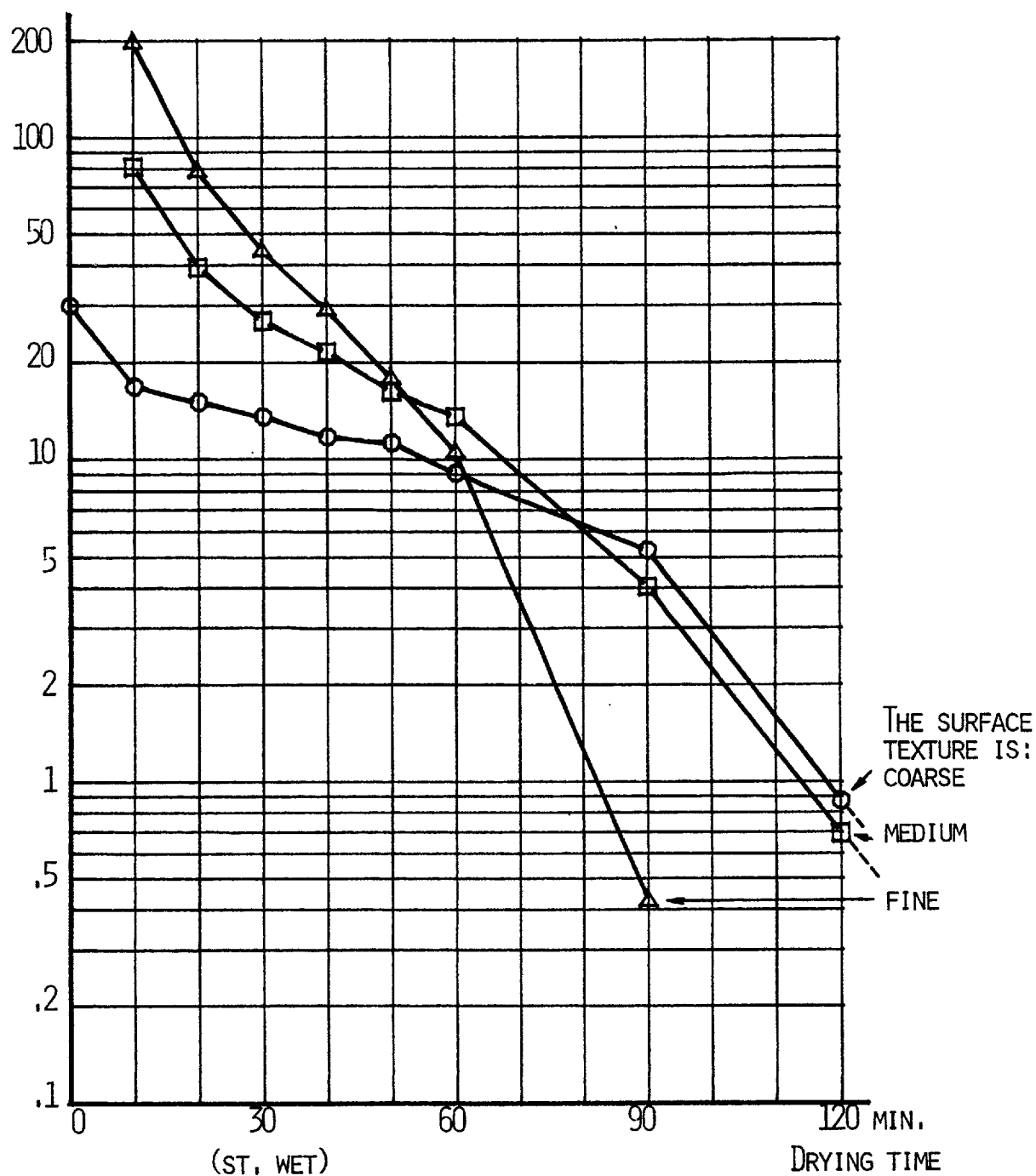


Fig. 1

The degree of specularity, S1' (see section 2.4) of three road samples of different surface textures, as a function of the drying time, after having been exposed to a simulated rainfall of 5 mm per hour.

The more coarse the road sample is, the lower is the initial degree of specularity, and the longer the drying takes.

The standard wet condition (see section 2.2) is the one reached after 30 min. of drying time.

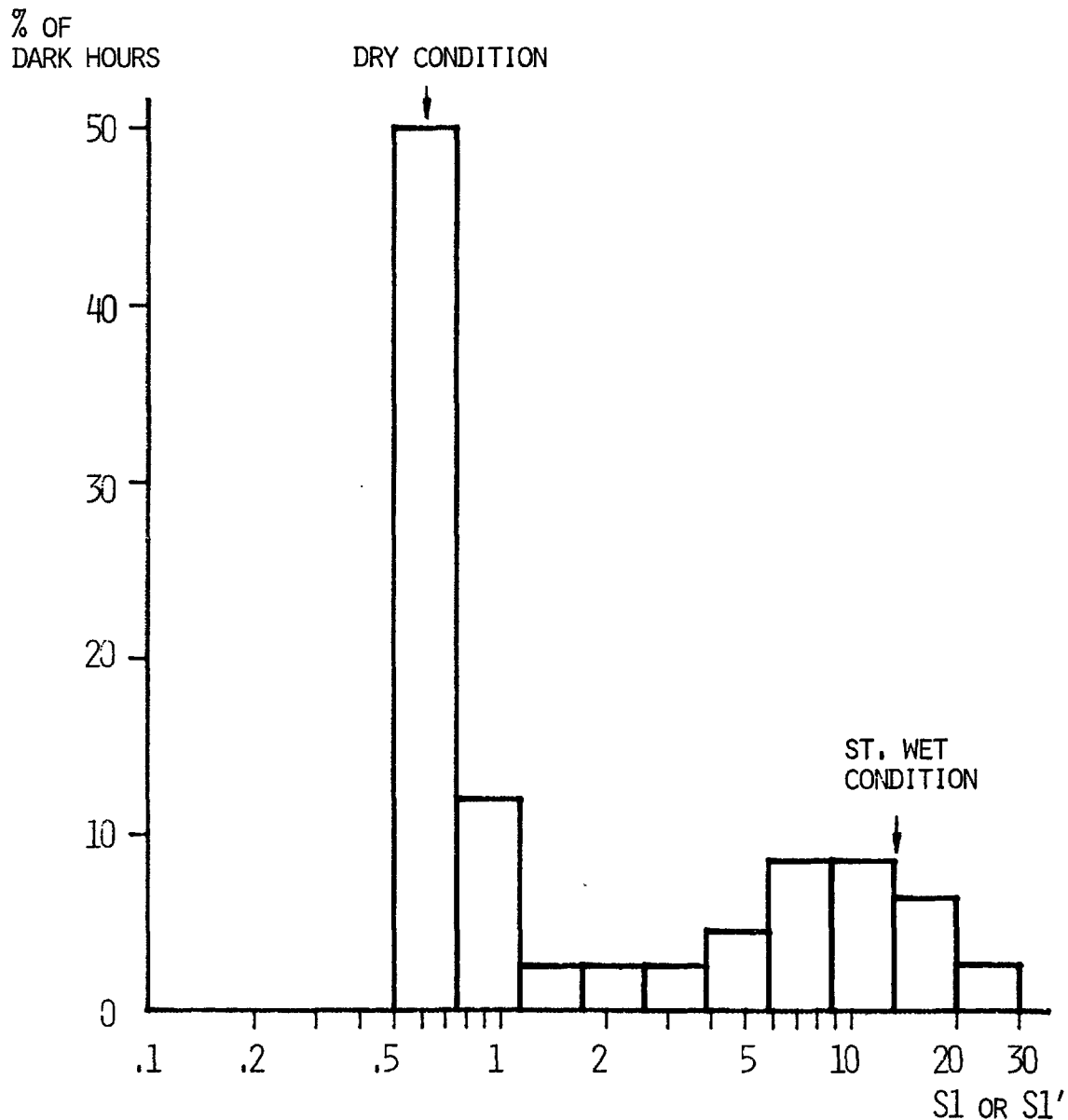


Fig. 2

The distribution of durations of the degree of specularity, S_1 for the dry condition and S_1' for the wet conditions (see section 2.4), for a road sample exposed to the Danish weather during the dark hours of the year 1972.

The road sample is the one for which circles are used in fig. 1.

The large peak around $S_1=0.6$ is due to the dry condition, while the wet conditions have a range of higher degrees of specularity.

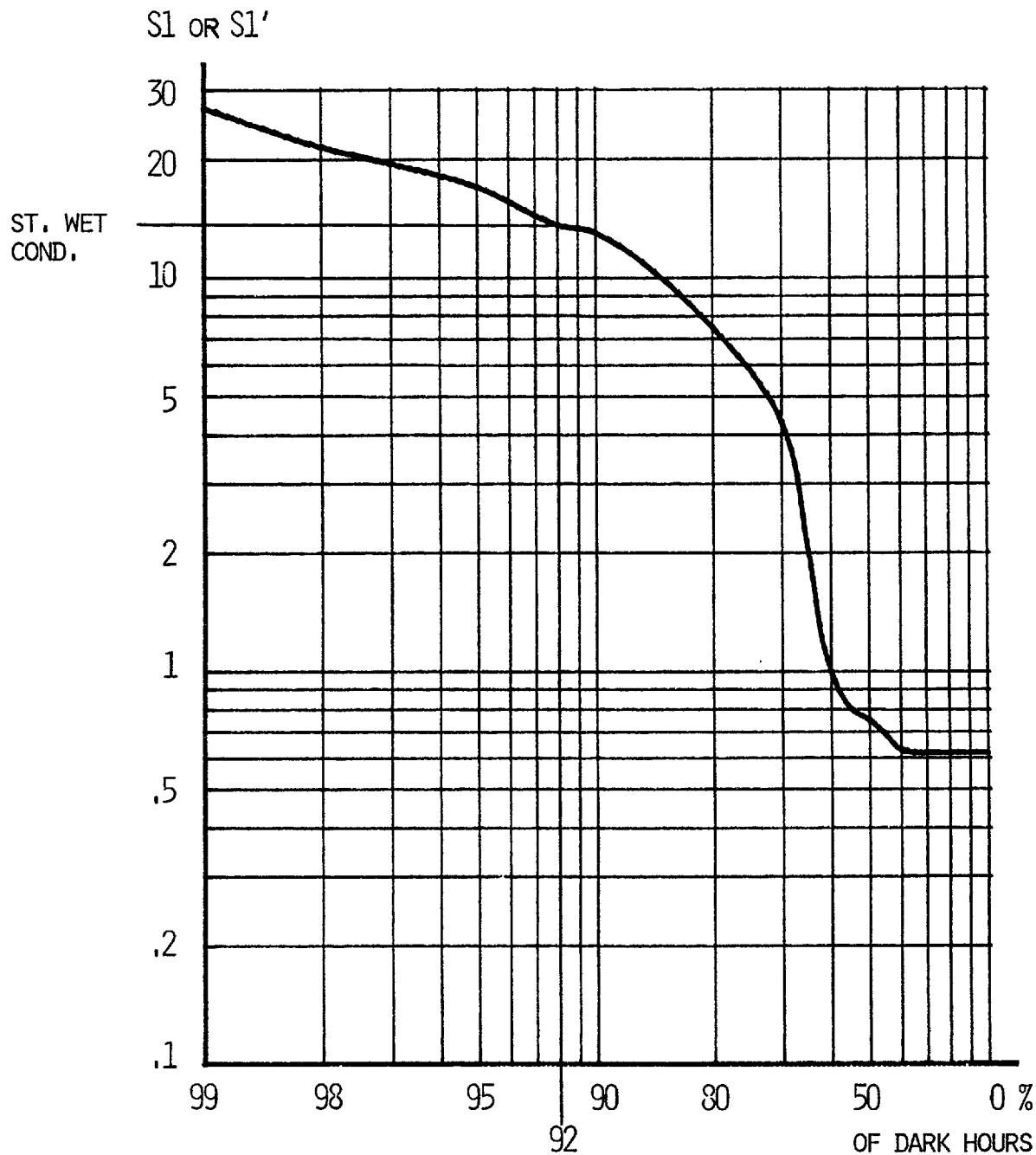


Fig. 3 The sum of the distribution of durations in fig. 2. The curve gives the fraction of the dark hours, in which the degree of specularity is lower than the levels (S1 or S1', see section 2.4) on the ordinate axis. The standard wet condition (see section 2.2) covers 92% of the dark hours in this case.

2.2.2 Definition of the wet condition

In CIE Publication No. 30, the "standard wet condition" is, for the time being, defined as the wet condition which occurs on a road sample 30 min after switching off a simulated rainfall of 5 mm per hour, with 50 % humidity at 25°C. The simulated rainfall can be achieved by means of the method outlined in Appendix C.

This definition is chosen on the basis of measurements of durations of wet conditions on 20 road samples exposed to the Danish climate, in which the standard wet condition covers approximately 90 %, and the dry condition alone approximately 50 % of the dark hours.

The definition of the standard wet condition is applicable for climates similar to the Danish, which has frequent wet weather and approximately 750 mm of rain evenly distributed throughout the year. For other climatological zones, different definitions of the wet condition should eventually be determined. This cannot, however, be done at present, owing to lack of data. Therefore, in this report the standard wet condition of CIE Publication No. 30 is used, whenever there is need to discuss a representative wet condition.

2.3 Description of road reflection properties

2.3.1 General remarks

Description methods are introduced in order to:

- give a general impression of the reflection properties of a road surface
- allow an easy comparison of road surfaces
- form the basis of a classification
- form the basis of simplified in situ measurements of road reflection properties

From these considerations, the requirements of a description method are,

firstly, that it should be based on a small number of characteristic parameters, which should reflect the basic reflection concepts, i.e. lightness and specular properties, and, secondly, that the accuracy should be good.

The ultimate test of the accuracy of a description method is that any two road surfaces with close sets of the characteristic parameters must give close sets of luminance characteristics for any conventional lighting installation.

In recent years a lot of research into description methods has been carried out along the principles outlined above. Most of this research concerned reflection properties of dry road surfaces and has resulted in the description method proposed in CIE Publication No. 30, which is outlined in the next section.

More recently, continued research has resulted in a proposal for a simple, unified description method for the dry and the wet condition. See Frederiksen and Sørensen (1976). This description method, which is an extension of the CIE method, is given in the following sections.

2.3.2 The CIE description method

The description method of CIE Publication No. 30 is defined by means of three characteristics:

The average luminance coefficient, Q_0
 Specular factor 1, S_1
 Specular factor 2, S_2

where Q_0 is averaged within a specified solid angle, see CIE Publication No. 30

$$S_1 = \frac{r(\beta=0, \tan\gamma = 2)}{r(\beta=0, \tan\gamma = 0)}$$

$$S_2 = \frac{Q_0}{r(\beta=0, \tan\gamma = 0)}$$

This description method is accurate within the limits given in CIE Publication No. 30 for dry road surfaces, but, as clearly stated in the CIE document, the accuracy is considerably reduced for wet road surfaces, and therefore, a revision of the method was foreseen.

2.3.3 Recent developments in the description of reflection properties of wet road samples

2.3.3.1 Background

The major cause of the reduction in the significance of the $S1$ and $S2$ specular factors for the wet condition is apparent from the two iso- r diagrams in fig. 4. Both of these are for wet surfaces with similar values of $S1$ and $S2$ but different values of $Q0$.

If the factors $S1$ and $S2$ were suitable for the classification of wet road surfaces, it would be expected that the uniformity of luminance for the two surfaces would be similar. In fact, the uniformity obtained with the fig. 4a surface is very much less than that obtained with the fig. 4b surface. The reason for this is that the fig. 4b surface gives a much broader tail to the T , as shown by the longish curves along the axis of the diagrams.

The tail to the T on a wet surface is largely produced by the specular reflections from the water film on the facets of the stones making up the road surface. The more coarse the texture of the road surface (i.e., the more the facets are inclined on the average), the more the water film is broken up. Hence the reflected light is not as bright but comes from a wider area. It is found in this case that $Q0$ is low. The opposite is true of a smooth surface that is wet, so that a bright narrow tail is produced and $Q0$ is high.

2.3.3.2 Choice of description system

The previous section suggested that $Q0$ is related to the breadth of the tail of the iso- r diagram, whereas $S1$ and $S2$ are related to the way the light is reflected along the axis of the iso- r diagram.

Hence for a two parameter classification system it would seem reasonable to consider the suitability of $Q0$ and either $S1$ and $S2$. $S2$ is dependent on the value of $Q0$, so $Q0$ and $S1$ were selected for further investigation. This investigation comprised wet road surfaces of a moderate degree of

specularity only, since surfaces that tend to give extremely small luminance uniformities in the wet condition were disregarded.

Fig. 5 shows the scatter of points obtained when Q_0 is plotted against S_1 for a number of road surfaces. These were arbitrarily divided into four classes. An optimization process was then used to minimize the error in calculating average and minimum luminance, and overall, longitudinal and transverse uniformity of luminance. By the error is meant the average error obtained, when any two surfaces within a class replace each other in the luminance calculations. The r -table which contributed most to the overall error was then moved to another class. If the overall error for the four classes was reduced the change was accepted, if not, it was rejected. This process was carried on until no further improvement could be made.

Although by this optimization process the 3 boundary lines, (A lines, fig. 5) did not meet at a point, it was found that only a small adjustment was needed to make them do so. This made the class boundaries easy to define by specifying this point of intersection, and the point of intersection on the S_1 axis, S_1' .

Since the common point of intersection is $S_1 = 0.147$ and $Q_0 = 0.687$, the equation of the boundary lines is given by:

$$\log (S_1'/0.147) = \frac{\log((S_1\text{-wet})/0.147)}{1-(Q_0\text{-wet})/0.687}$$

Any point on the graph can be located by an S_1' and a Q_0 value. S_1' tends to govern the uniformity of luminance, that is, road surfaces lying on the same A line give a similar uniformity of luminance. $Q_0\text{-wet}$ tends to govern the lightness and, therefore, the average luminance of the road surface.

On fig. 5, road surfaces with the same $Q_0\text{-dry}$ lie on the B curves. The value of $Q_0\text{-dry}$ is given by the value of $Q_0\text{-wet}$ for the curves at a low value of S_1 . Thus, it appears that $Q_0\text{-dry}$, $Q_0\text{-wet}$ and S_1' are interrelated. If $Q_0\text{-dry}/Q_0\text{-wet}$ is plotted against S_1' (fig. 6) a straight line correlation is obtained. This indicates that it is possible to use $Q_0\text{-dry}$ in place of $Q_0\text{-wet}$.

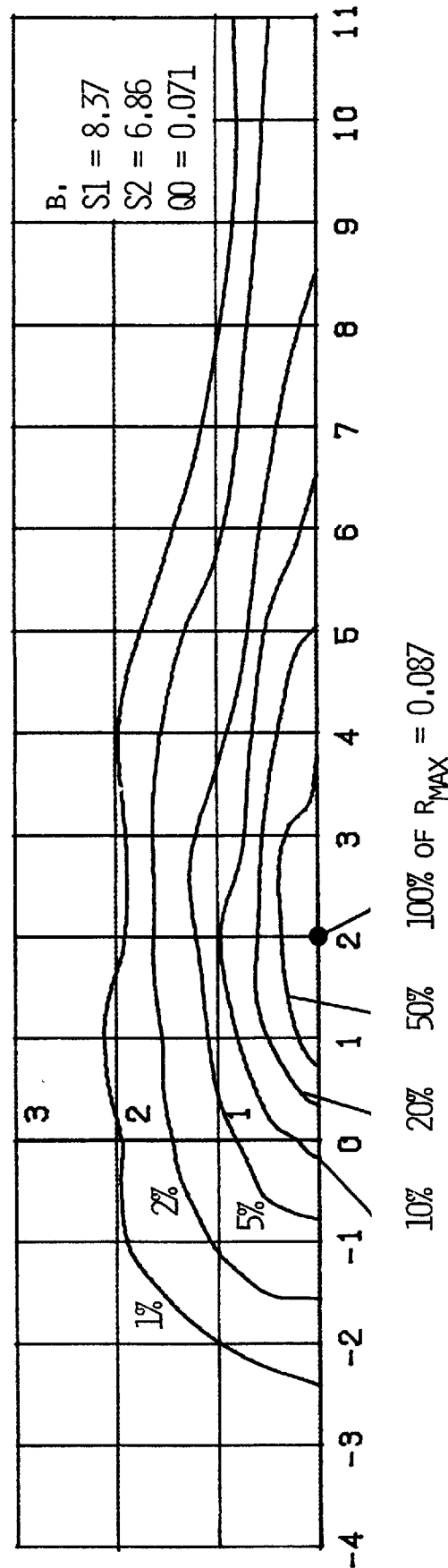
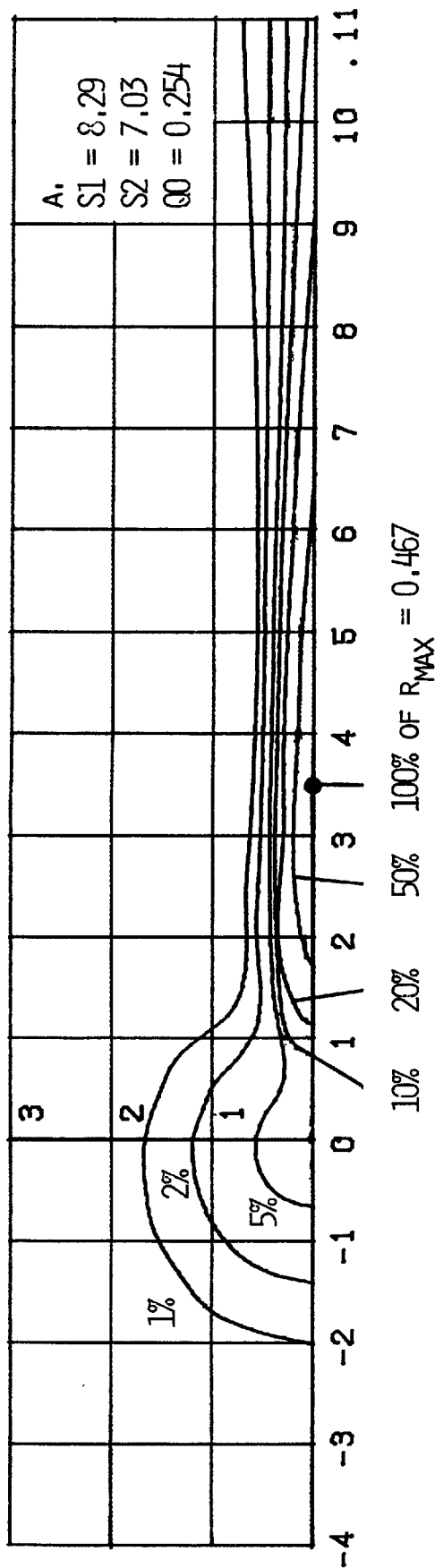


Fig. 4 Iso-r diagrams for two wet road surfaces of close $S1$ and $S2$ values (reduced to $r_{max} = 100\%$). The diagrams are widely different in spite of the similarity in $S1$ and $S2$. (An Iso-r diagram represents the luminance distribution on the road, as seen from a large distance to the right-hand side, when illuminated by a light source of constant luminous intensity, mounted in unity height above the origin of the diagram).

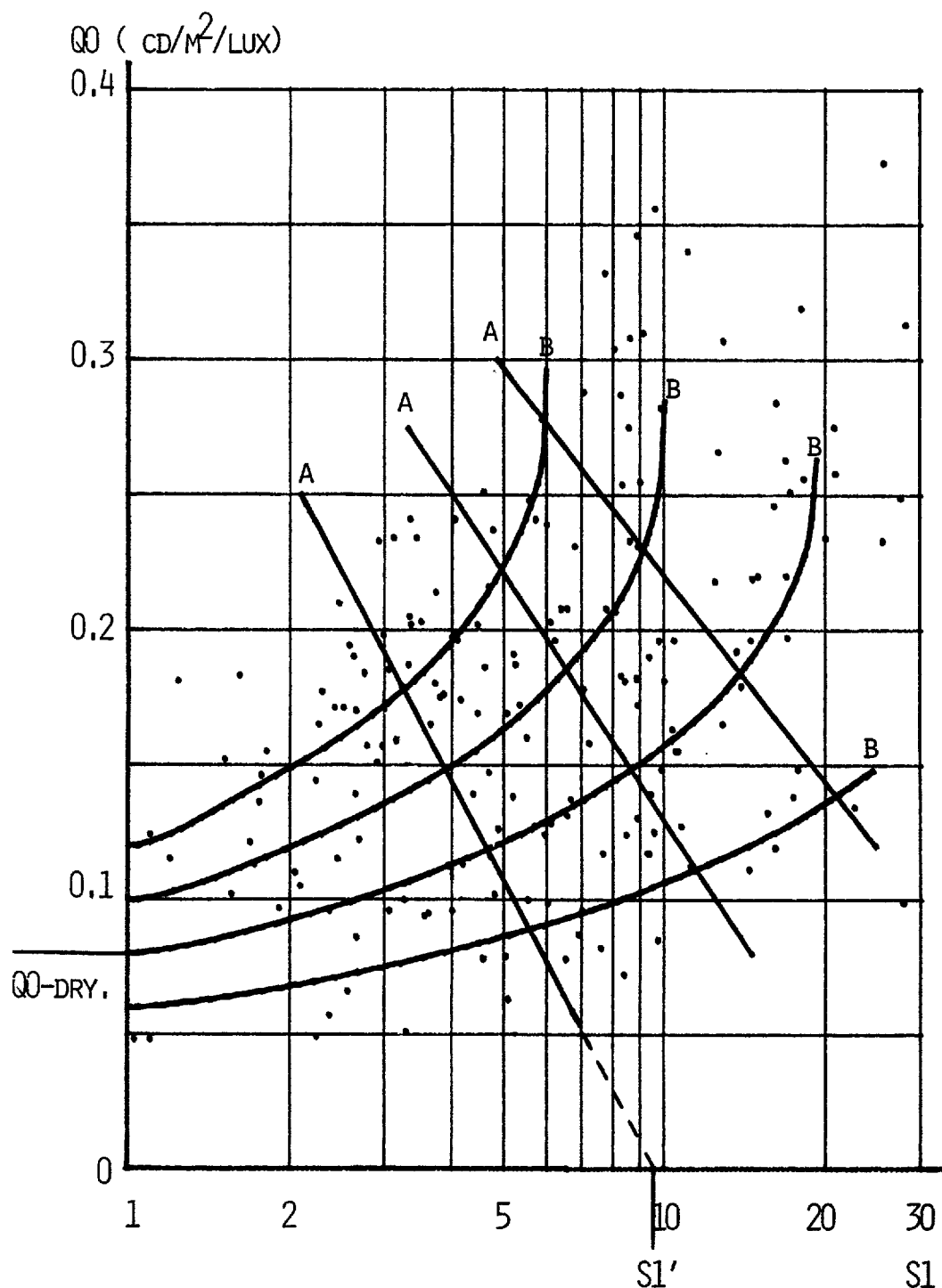


Fig. 5. S_1 - Q_0 diagram with a number of measurements on standard wet road surfaces indicated by points. Points lying along one of the lines A correspond to road surfaces of approximately the same effective degree of specularity, as characterized by the S_1 -value of the intersection of the line with the S_1 -axis, S_1' . Points lying along one of the curves B correspond to road surfaces of approximately the same effective lightness, as characterized by the Q_0 at low S_1 -values, which is $Q_0\text{-dry.}$

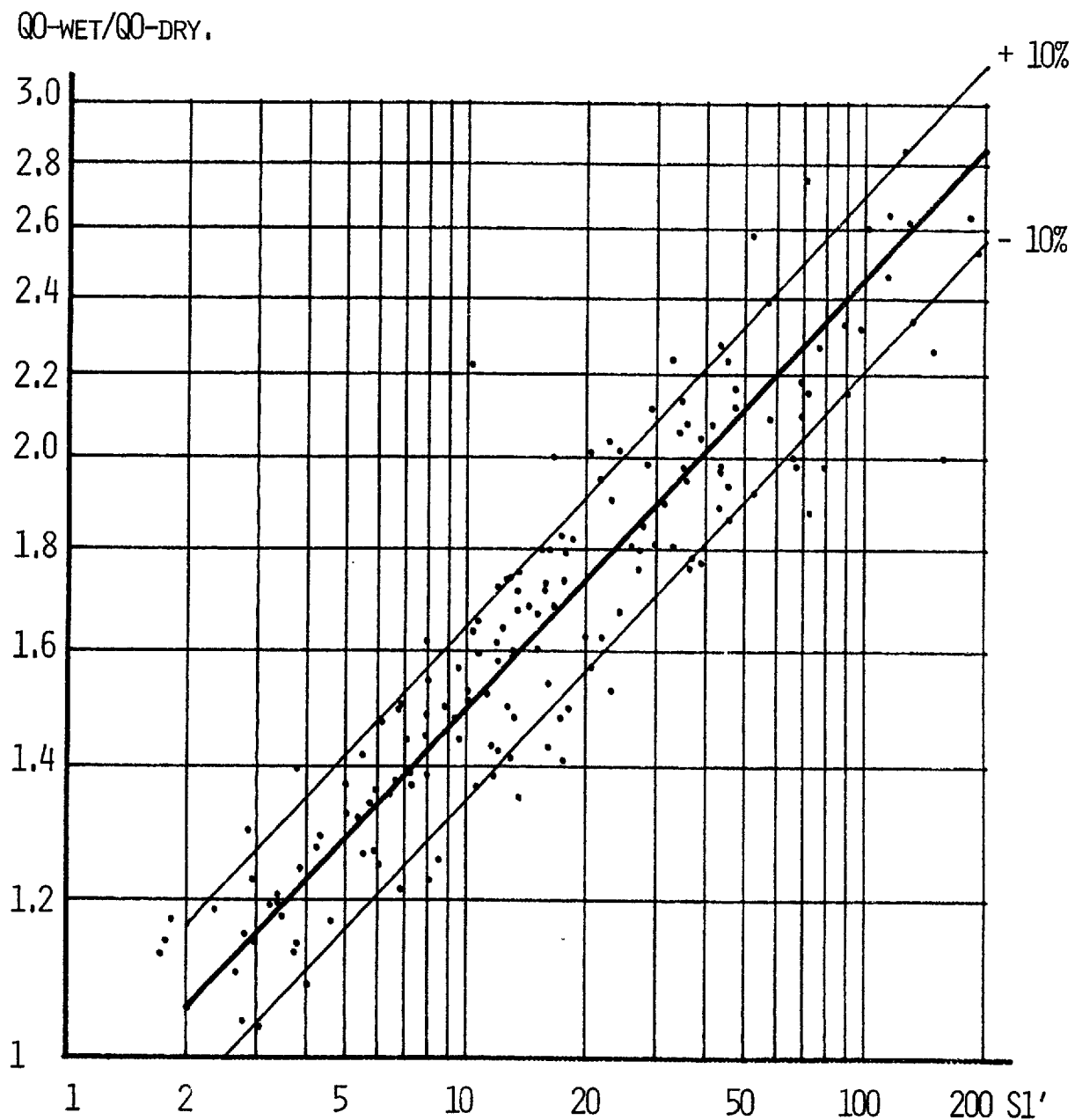


Fig. 6. The ratio between Q0-wet and Q0-dry as a function of $S1'$.
 Q0-wet and $S1'$ are for the standard wet condition.
 Most of the road surfaces fall within the lines of $\pm 10\%$ from
 the central line.

Hence only one new parameter, $S1'$, need be introduced to describe wet surfaces. The other factor, $Q0$, is already used for dry surfaces, and may be used as a scaling factor for lightness for both dry and wet surfaces.

2.4 A unified description method for road reflection properties in dry and wet conditions (provisional)

2.4.1 General remarks

The description method is based on the description method for dry road surfaces of CIE Publication No. 30, which has been revised with the aim of including wet surfaces into the description.

The second specular factor, $S2$ of the description method of CIE Publication No. 30 is not included in the outline of the unified method to follow, but otherwise the two methods are compatible for dry road surfaces, both of them use $Q0$ and $S1$. For wet road surfaces the corrected specular factor, $S1'$ is introduced, and $Q0$ for the dry condition is also used as a scaling factor for the wet condition. These modifications are based on, and tested by, measurements on wet road samples taken, mainly, from Swedish and Danish roads.

For the time being, the description method defined in the following can be used, but the ultimate test of the method must await measurements on wet road surfaces in more countries.

2.4.2 Definition of the characteristics

The three characteristic parameters to be used are:

$Q0$ -dry The average luminance coefficient of the dry surface, $Q0$ -dry as a measure of the lightness of the road surface in dry or wet conditions.

S1-dry The specular factor 1 of the dry surface, S1-dry as a measure of the specular properties of the dry surface.

S1' The corrected specular factor, S1' as a measure of the specular properties of the wet surface.

Q0 and S1 are defined in CIE Publication No. 30.

S1' is determined from Q0 and S1 for the wet surface, Q0-wet and S1-wet (by page 21, paragraph 5) by means of:

$$\log(S1'/0.147) = \frac{\log((S1\text{-wet})/0.147)}{1 - (Q0\text{-wet})/0.687}$$

where, however, S1' = S1-wet in the few practical cases where S1-wet < 1. This means a small discontinuity in the scale, which, however, has no practical significance.

2.4.3 The use of the description method

The description method is intended for research and development purposes, and for a basis for simplified measurements of road reflection properties in dry and wet conditions.

When Q0-dry, S1-dry and S1' are determined by means of a suitable instrument the proper r-tables, to be used in luminance calculations, are selected:

- a. either by means of the classifications given in section 2.5.
- b. or by selecting an r-table for the dry condition of the proper S1-dry and an r-table for the wet condition of the proper S1' and rescaling both r-tables to the measured Q0-dry.
Erbay (1974) has published a collection of r-tables for the dry condition. Report No. 10 of the Danish Illuminating Engineering Laboratory (1975) gives collections of r-tables for both dry and standard wet condition.

The accuracy in luminance calculations, excluding measuring uncertainty, can be expected to be within:

	in dry	in wet*	
for average luminance approximately	5 %	10 %	(RMS)
for overall uniformity approximately	6 %	18 %	(RMS)
for longitudinal uniformity approximately	8 %	19 %	(RMS)

*The accuracy figures for the wet condition are confirmed for Swedish and Danish road surfaces only.

2.5 A unified classification of road reflection properties in dry and wet conditions (provisional)

2.5.1 Introductory remarks

A classification is based on a description method. The classification is defined when the total range of specular properties is divided into a number of smaller ranges or classes and a standard reflectance table is given for each class.

The choice of the classes should be made in such a way that most (but not necessarily all) of the normal variations of a road surface, excluding those caused by wet weather, fall within a class. Each class should, on the other hand, be so small that the standard reflectance table represents all of the surfaces within the class to a reasonable accuracy. All lighting calculations are carried out with the standard reflectance tables.

The advantages of using a classification method are, among others, that random variations of the reflection properties of the surfaces in question do not enter into the evaluation of the luminance pattern of a lighting installation, and that lighting calculations and documentation of lantern performance data are made easier.

The problem of classifying dry road surfaces is discussed in CIE Publication 30. It is concluded that a relatively small number of classes is sufficient and that the ranges of such classes can be defined by means of the specular parameter S_l only. However, complete classifications are not given, but instead two sets of standard reflection tables, the R- and the N-series are defined.

In fig. 7 the positions of the R- and the N-standards are shown in an S1-S2 diagram in order to give some impression of the specular properties that they represent.

2.5.2 Outline of a unified classification for road reflection properties in dry and wet conditions

Frederiksen and Sørensen (1976) have proposed a unified classification, which is based on the description method of section 2.4.

The classification consists of one classification for the dry condition and one for the wet condition. In the proposal, the classification for the dry condition uses the N-standards, but a similar classification based on the R-standards can in principle be used as well. This is taken into account in the following outline of the systems:

- a. the specularity in the dry condition, i.e. S1, determines the reflection class for the dry surface. This reflection class is R1, R2, R3 or R4 in a classification based on the R-standards and N1, N2, N3 or N4, when the classification is based on the N-standards.
- b. the specularity in the wet condition, i.e. S1', determines the W-class, W1, W2, W3, W4 or even higher degrees of specularity, that are not classified.
- c. the "lightness" of the road surface, i.e. Q0-dry, is not subject to classification.

For the N-standards the ranges of classes are shown in fig. 8. For the R-standards such ranges have not yet been defined by means of S1. The standard r-tables can be found in CIE Publication No. 30. The ranges of the W-classes are shown in fig. 9, while the tables themselves are found in tables 1 to 4.

Road surfaces with almost any combination of classes for dry and wet can be met with in practice. A number of road surfaces have a specularity in wet that exceeds class W4.

2.5.3 Example of use of the classification

When providing r-tables for a road surface, there should be sufficient information for the determination of Q0-dry and the classes for the dry and the wet condition of the road surface. Let the following be obtained by measurement:

For the dry condition

Q0-dry = 0.059

S1 = 0.934

For the wet condition

Q0 = 0.134

S1 = 22.61

which gives $S1' = 76.6$ according to section 2.4.2.

From figs. 8 and 9 is seen that the classes N3 and W4 apply for the dry and the wet condition respectively. For the dry condition class R3 can probably be used as well.

Since table N3 is for a scale value Q0-dry = 0.07 and a Q0-dry of 0.059 is actually measured, the table has to be multiplied by $0.059/0.07 = 0.84$ before being used. Similarly the scale of table W4 is Q0-dry = 0.104, so that this table has to be multiplied by $0.059/0.104 = 0.57$

The rescaled tables are used as input in luminance calculations for the road surface in question. The accuracy, excluding measuring uncertainty, can be expected to be within:

	in dry*	in wet**	
for average luminance approximately	6 %	11 %	(RMS)
for overall uniformity approximately	8 %	20 %	(RMS)
for longitudinal uniformity approximately	10 %	20 %	(RMS)

* these figures are valid for the N-classification.

**these figures are confirmed for Swedish and Danish road surfaces only.