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本期关键词

智能交通世界大会

视频检测器

摄像机

上海高德威智能交通系统有限公司



卓越品质
源于实践

主要产品:

- 汽车牌照识别器
- 视频检测器
- 车辆智能监测记录系统(治安卡口)

应用领域:

- * 高速公路收费管理
- * 高速公路、公路、城市道路交通信息采集
- * 公安卡口车辆管理
- * 交通量调查
- * 隧道、桥梁、道路交通事件检测
- * 停车场、称重、海关系统应用

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面向智能交通领域管理者和专业技术人员的技术经济类期刊

新技术助力隧道安全 New Technologies for Safety Improvement in Tunnels

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【摘要】

中国现有公路隧道2889个,其中特长隧道有43个、165.9公里。今后一段时期,中国公路建设将持续增速,且主要集中在中西部地区,公路隧道数量也将进一步快速增长,保证隧道交通流的安全畅通逐渐成为隧道运营管理部门的关注热点。除了运用先进的车流组织理论和采用稳定的机电设备,研究司机的行为特征、驾驶习惯以及使隧道的设计、施工、使用更加人性化,更应受到重视。本文介绍了燧石(即耐火石)反光、散热、价格低廉等特性,以及在隧道施工中,其作为增亮剂与沥青混合后加铺,改善隧道内光线强度所达到的效果,并引用了在德国Keppelberg隧道改造工程中的应用实例。

Rapid expansion of China's road network

The long-term plan of Ministry of Communication, published in January 2005, contains the extension of the expressway network to 65,000 km within the next 5 years. Until 2020 this figure shall grow to 85,000 km totally. Thus reaching almost the same level like the US, with an approximate of 90,000 km.

The highway network shall grow to a total of 3 million km by 2020. Most of the new roads are constructed in Central and West China.

The roads in the plan will include 7 routes, which start from Beijing in a radial frame, 9 North-South connections and 18 East-West routes. Therefore it is also called "7918 Network". This "7918 Network" shall connect all cities with more than 200,000 inhabitants as well as 50 railway interconnections, 67 airports and 50 harbors. Moreover China will build village-to-village roads and provincial level trunk

roads. By 2010 China will have 2,3 million km, which includes the above-mentioned network of expressways.



Tunnels in China

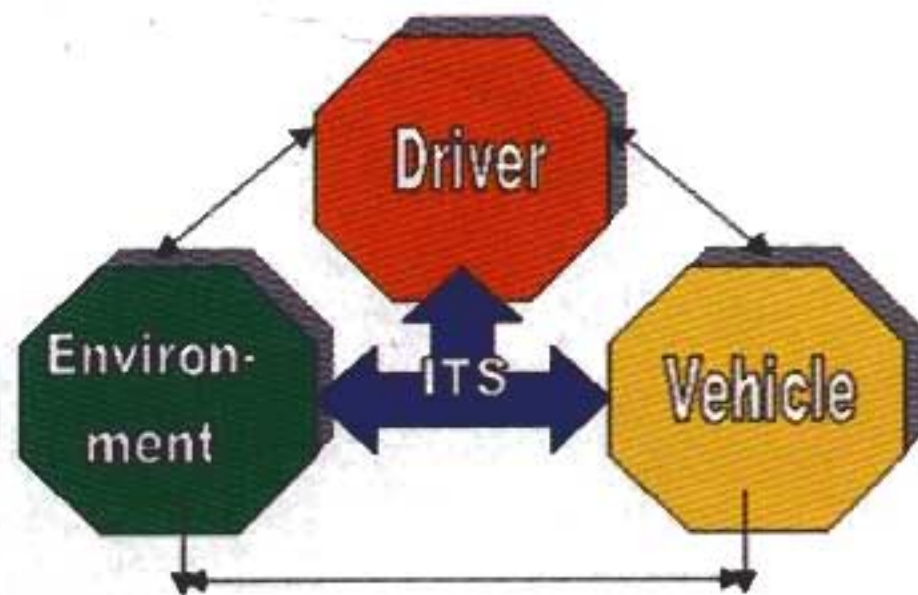
So far, there are an approximate total of 10,000 tunnels in China. Out of this figure 2,

889 are road tunnels with a total length of 1,527 km. 43 tunnels have an extraordinary length (165.9 km in total).

In order to secure a proper traffic flow outside and inside a tunnel, a comprehensive concept of transportation and communication is a basic requirement, which allows a quick reaction to any kind of traffic conditions. Besides, the consideration of energy saving systems and the use of improved technologies to maintain a certain level of brightness to ensure a high level of safety for the tunnel user.

Human factor in traffic

Driving behavior may be understood as a circuit of the components driver, vehicle and environment = road + surrounding.



Physical factors:

$$(f_r + a) = v^2 / g * r$$

Since the environment is changing steadily, the driver permanently assimilates and processes information to adopt his driving style to the respective traffic situation.

Approximately 90 % of all relevant traffic information, for example about obstacles, other road users, the course of the road, signal, changes in the environment, etc. is assimilated visually.

How to adopt driver's eyes to changing conditions

Considering that the eyes of the driver must get used to a different environment on entering the tunnel i.e. from bright daylight to the dark interior of the tunnel, we have to find the right measurements to support the driver.

The required basic brightness is calculated in different sections of the tunnel.

In the arrival area of the tunnel

$$L_{tn} = k \times L_{20}$$

The luminous density in the arrival section in daytime L_{20} is considered as a measurement for the visibility conditions for this distance.

Following the arrival section, we have the transition section. Within this section the luminous density shall be reduced to the conditions inside the tunnel area.

$$L_{tr} > L_{tn} \times (1.9 + t)^{-1.423}$$

For the inner section of the tunnel, we have to bear in mind that the luminous density must be three times higher in emergency areas than in the carriageway.

Normally the exit section does not require a divergence from the luminous density of the inner section.

The values of the brightness are different, depending on daytime and nighttime and also the weather conditions. Furthermore we have to take into account that the blinding values



caused by the lighting equipment must be limited.

Optical brightening agent for asphalt

In order to achieve a certain level of basic brightness inside the tunnel there are agents available, which are added to the asphalt.

Flint is burnt firestone. It is treated at temperatures of 1200 degree Celsius. This process dehumidifies the flint giving the stone its white color and its characteristic features. This crystalline stone structure creates a special heat and light reflection. After the heating procedure the flint is crushed and classified according to size.

The flint coming from Denmark has a hardness of 7 according to the Moh' scala. (the hardness of diamonds is 9).

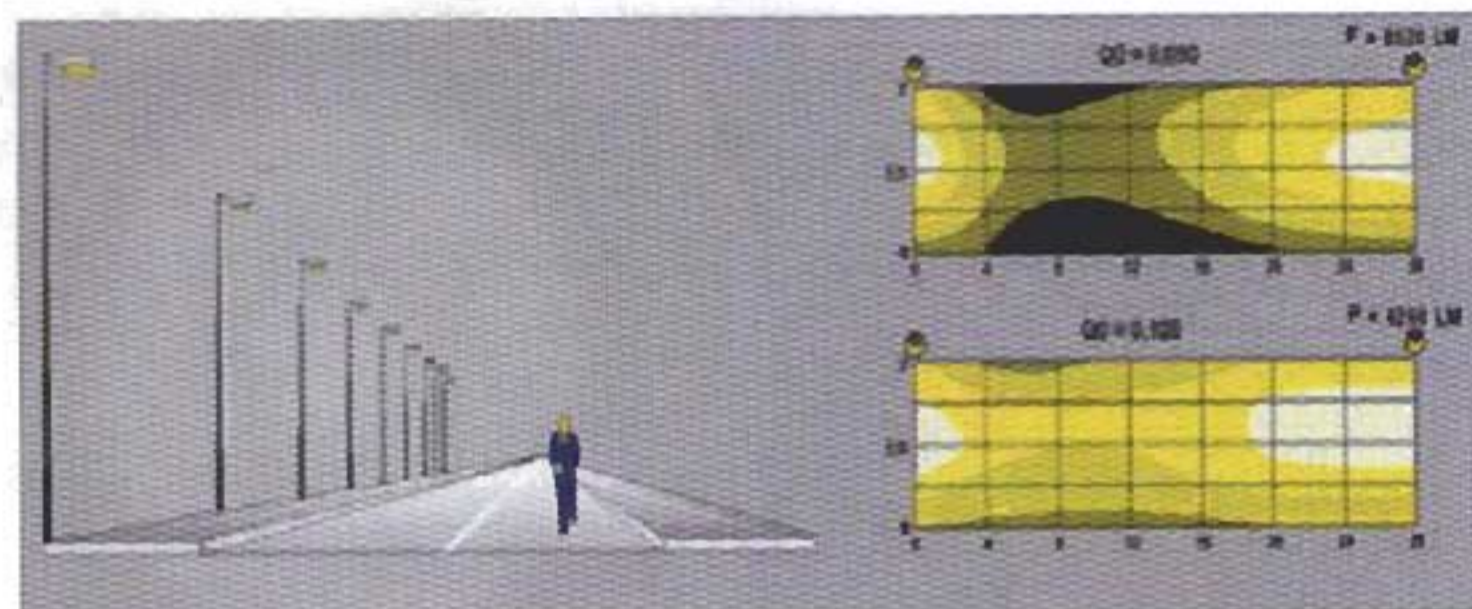
It shows a high luminous density coefficient and also reflects in wet and dry condition of the asphalt, which is a relevant aspect in the entrance and exit area of tunnels. Another advantage is its characteristic of heat reflection.

Chemical composition of the Danish flint:

SiO	approx.	97%
N _{a2} O+K ₂ O+M _g O	approx.	1%
CaO	approx.	5/4%
Fe ₂ O ₃	approx.	1/4%
Al ₂ O ₃	approx.	1/2%

Specific weight
approx. 2.35 g/cm³

The flint is a low cost add-up to the asphalt, thus having a positive effect to the budget of the tunnel projects and also increases road safety by means of improved contrast viewing and increasing the gripping surface.



The graphics show the vision from the view of the road user.
reflection of a black surface
reflection of a light surface

Newly renovated Tunnel in Germany

The Kappelberg Tunnel near Stuttgart in South Germany has recently been renovated. According to Mr. Wolfgang Tress, Administrative Supervisor of the project and a member of the German Tunnel Committee, they are using the Danish flint in this project and also a brightening agent for the walls. So far the observations have shown positive and satisfying results.



Entrance section of the newly renovated Kappelberg Tunnel, Germany.



Inner section of the newly renovated Kappelberg Tunnel, Germany

The asphalt is very bright thus improving the light intensity inside the tunnel. The "lacquered" walls also contribute to this positive effect. Due to the installation of Swaroline LED modules the number of lights in daily use could be reduced considerably.

Conclusions

Considering the specific characteristics of tunnels there is a lot to be coordinated to create a certain level of safety for

the road user with his behavior

the operator, who bears a high degree of responsibility

the environment by choosing the best combination of technologies

Optical brightening agents drastically cut the maintenance cost due to their long lasting brightening effect. With regard to the energy cost we may note that they increase the luminous intensity which has a positive effect to the light density.

They also have a very positive impact on

the safety because they help the road user to adopt his eyes to the new surrounding when entering and leaving a tunnel.

This effect can additionally be increased by using LED modules for traffic guidance inside the tunnel. There are LED modules in the market, which work with 24 V DC only, thus having a positive effect on the energy budget of the tunnel project. They are operated via control units, which can either be directly connected to the tunnel center or work independently.

Nowadays, there are number of highly sophisticated products and systems in the market offering perfect technology to increase safety and save energy. At the same time they are also considering the needs of our environment and the behaviors of human in traffic.

It is simply a question of the correct use and the most suitable combination of the systems to achieve the utmost effective and cost efficient results. ■