

# Design of Highway Icing Warning System

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**Abstract:** This paper introduces the design scheme of expressway pavement icing detection system, and adopts the method of combining vibration propagation, whether the temperature reaches freezing point, and the change of electrical conductivity to comprehensively judge the icing condition of the pavement. As a node in the wireless sensor network of traffic weather station, the system has the characteristics of flexible networking, low cost and low power consumption. This design includes solar floor lamp and solar LED display screen. This design adopts a facility device consisting of a solar floor lamp and a solar LED display screen. The solar floor lamp is provided with a solar photovoltaic cell, a charging and discharging cell, a red and green LED lamp, a temperature and humidity sensor and a D data processing and transmission chip circuit. The solar LED display screen is provided with a solar photovoltaic cell, a charging and discharging cell, an LED graphic display screen, a P data processing and transmission chip circuit and a red flashing warning light; According to the technical scheme that red light and graphic warning are sent out according to freezing critical data collected from the ground, and the data are transmitted to the traffic control center through the Internet, the problem and deficiency that it is difficult to issue road freezing warning in real time in the prior art are overcome, so that the expressway can issue road freezing warning in real time.

**Keywords:** real-time warning, highway pavement, icing

## 1. Introduction

In recent years, China's expressway construction has continued to develop, and the scale of road network has been expanding day by day. The three systems engineering technologies of expressway communication, monitoring and toll collection have developed rapidly. Among them, road monitoring is the key project to ensure the safe driving of expressway, especially, the meteorological factors such as road icing in road monitoring system are closely related to traffic accidents. Wireless sensor network integrates sensor technology and network communication technology, involving information collection, processing and transmission. There are many meteorological elements involved in meteorological observation, and the elements are interrelated, so wireless sensor networks are very suitable for meteorological observation [1]. The sensor detection units such as vibration, temperature and electrical conductivity are used to collect the icing condition of the road surface, and the measured data are sent to the data communicator in the network at regular intervals, which constitutes the icing sensor network node for traffic meteorological observation [2].

In the freezing winter when it rains and snows, the pavement of expressway is prone to freeze and freeze, which seriously endangers the driving safety of vehicles, so it is necessary to send a warning to the driving vehicles in time. In the prior art, the warning is issued to the driving vehicles through the LED information display screen arranged along the expressway according to the weather situation and weather forecast. Due to the meteorological phenomenon of "ten miles in different days" on mountain expressways [3], and the fact that the information release center of expressways is far away from the mountainous expressway area where freezing rain is happening, it is difficult to release the warning of pavement freezing in real time. In addition, the bridge deck of highway bridges is prone to freeze before the highway pavement due to the lack of geothermal energy, and if there is no real-time warning of pavement freezing here, it will bring great security risks to driving vehicles. Therefore, the existing technology has the problems and shortcomings that it is difficult to issue the road freezing warning in real time [4].

## 2. Design content

In view of the problems and shortcomings in the prior art, this design adopts a facility device consisting of a solar floor lamp and a solar LED display screen, wherein the solar floor lamp is provided with a solar photovoltaic cell, a charging and discharging cell, a red and green LED lamp, a temperature and humidity sensor and a D data processing and transmission chip circuit; The solar LED display screen is provided with a solar photovoltaic cell, a charging and discharging cell, an LED graphic display screen, a P data processing and transmission chip circuit and a red flashing warning light<sup>[5]</sup>; When in use, the solar LED display screen is arranged on the right side of the road along the road running direction, and a plurality of ground lamp arrays are arranged and buried on the road 50-300 meters in front of the solar LED display screen along the road running direction. When the road surface freezes, the temperature and humidity sensors of the solar floor lamp will process the freezing critical data collected from the ground through the D data processing and transmission chip circuit, and the D data processing and transmission chip circuit will turn the LED lamp of the solar floor lamp from green to red, emit flashing warning red light<sup>[6]</sup>, and transmit the warning data to the solar LED display screen. The P data processing and transmission chip circuit of the solar LED display screen is used for processing, and the LED graphic display screen is turned on to send a graphic warning to the running vehicles, at the same time, the warning light is turned on to send a flashing warning red light, and the data is transmitted to the traffic control center through the Internet, so as to provide a safety facility device for real-time warning of highway pavement icing, aiming at sending red light and graphic warning according to the freezing critical data collected from the ground, so that the highway can achieve the purpose of real-time and real-time warning of pavement freezing<sup>[7]</sup>.

The purpose of this design is as follows: a safety facility device for real-time warning of highway pavement icing includes a solar floor lamp and a solar LED display screen, wherein the solar floor lamp is a device with a closed stainless steel shell outside and a solar photovoltaic cell, a charging and discharging battery, an LED lamp, a temperature and humidity sensor and a D data processing and transmission chip circuit inside; Transparent toughened glass is arranged on the shell; The detection end of the temperature and humidity sensor is exposed and flush with the upper surface of the shell; The LED lamp is a red and green LED light-emitting tube; D data processing and transmission chip circuit is a circuit board with the functions of processing the data of temperature and humidity sensors, controlling the turn-on and turn-off of LED lights and emitting flashing warning red light from green to red, and having the function of wireless data transmission with the P data processing and transmission chip circuit of solar LED display screen; Solar photovoltaic cells and charge-discharge cells are devices for providing power to D data processing and transmission chip circuits and LED lamps<sup>[8]</sup>.

The solar LED display screen is a device consisting of a P solar photovoltaic cell, a P charging and discharging cell, an LED graphic display screen, a P data processing and transmission chip circuit and a red flashing warning light. The LED graphic display screen is a rectangular flat box-shaped LED display screen, and the warning light is located on the outer surface of the LED graphic display screen; The P data processing and transmission chip circuit is a circuit board with the functions of processing the data transmitted by the D data processing and transmission chip circuit of the solar floor lamp, controlling the on-off warning light to blink on or off, and driving the LED graphic display screen for graphic display, and having the functions of wireless data transmission with the D data processing and transmission chip circuit of the solar floor lamp and transmitting the data to the traffic control center through the Internet; P solar photovoltaic cell and P charging and discharging cell are devices for providing power to P data processing and transmission chip circuit, LED graphic display screen and warning light; The solar LED display screen is arranged on the right roadside along the road driving direction, and the solar LED display screen faces the road driving direction; The solar floor lamps uniformly distributed in an array are called floor lamp arrays, and a plurality of floor lamp arrays are arranged and buried at intervals on the road surface 50-300 meters in front of the solar LED display screen along the road driving direction<sup>[9]</sup>.

## 3. Working principle and beneficial effects

When the road surface freezes, the temperature and humidity sensors of the solar floor lamp will process the freezing critical data collected from the ground through the D data processing and transmission chip circuit, and the D data processing and transmission chip circuit will turn the LED lamp of the solar floor lamp from green to red to emit flashing warning red light, and at the same time, the warning data will be transmitted to the solar LED display screen, which will be processed by the P data processing and transmission chip circuit of the solar LED display screen, and the LED graphic display

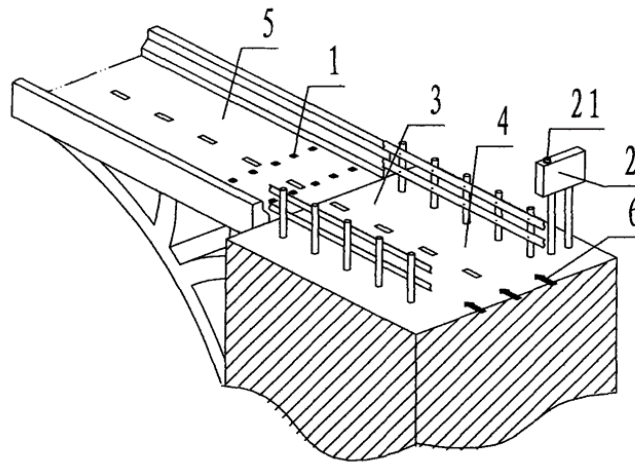
screen will be turned on to send a graphic warning to the driving vehicle, and the warning light will be turned on to send a flashing red warning, and the data will be transmitted to the traffic control center through the Internet [10].

The facility device sends out red light and graphic warning of road freezing according to freezing critical data collected from the ground in real time, so that the expressway can issue warning of road freezing in real time, and the harm of road freezing to passing vehicles is reduced.

#### 4. Beneficial design development

The solar floor lamp and the solar LED display screen of this facility can also carry out wired data transmission through data lines.

Above, this design adopts a facility device consisting of a solar floor lamp and a solar LED display screen. The solar floor lamp is provided with a solar photovoltaic cell, a charging and discharging cell, a red and green LED lamp, a temperature and humidity sensor and a D data processing and transmission chip circuit; The solar LED display screen is provided with a solar photovoltaic cell, a charging and discharging cell, an LED graphic display screen, a P data processing and transmission chip circuit and a red flashing warning light; When in use, the solar LED display screen is arranged on the right side of the road along the road running direction, and a plurality of ground lamp arrays are arranged and buried on the road 50-300 meters in front of the solar LED display screen along the road running direction. When the road surface freezes, the temperature and humidity sensors of the solar floor lamp will process the freezing critical data collected from the ground through the D data processing and transmission chip circuit, and the D data processing and transmission chip circuit will turn the LED lamp of the solar floor lamp from green to red, emit flashing warning red light, and transmit the warning data to the solar LED display screen. The P data processing and transmission chip circuit of the solar LED display screen is used for processing, and the LED graphic display screen is turned on to send a graphic warning to the running vehicles, and at the same time, the warning light is turned on to send a flashing warning red light, and the data is transmitted to the traffic control center through the Internet, which overcomes the problems and shortcomings of the prior art that it is difficult to issue the road freezing warning in real time. The safety facility device for warning the road freezing in real time provides a red light and graphic warning according to the freezing critical data collected from the ground, so that the expressway can be released in real time.



*In the figure: solar floor lamp 1, solar LED display screen 2, warning lamp 21, road surface 3, highway 4, bridge 5 and driving direction sign 6.*

*Figure 1: Schematic diagram of the structure*

#### 5. Specific mode of implementation

Referring to Figure. 1, a safety facility device for real-time warning of highway pavement icing is designed, which comprises a solar floor lamp and a solar LED display screen, wherein the solar floor lamp is a device with a closed stainless steel shell outside and a solar photovoltaic cell, a charging and discharging battery, an LED lamp, a temperature and humidity sensor and a D data processing and

transmission chip circuit inside; Transparent tempered glass is arranged on the shell; The detection end of the temperature and humidity sensor is exposed and flush with the upper surface of the shell; The LED lamp is a red and green LED light-emitting tube; D data processing and transmission chip circuit is a circuit board with the functions of processing the data of temperature and humidity sensors, controlling the turn-on and turn-off of LED lights and emitting flashing warning red light from green to red, and having the function of wireless data transmission with the P data processing and transmission chip circuit of solar LED display screen; Solar photovoltaic cells and charge-discharge cells are devices for providing power to D data processing and transmission chip circuits and LED lamps; The solar LED display screen is a device consisting of a P solar photovoltaic cell, a P charging and discharging cell, an LED graphic display screen, a P data processing and transmission chip circuit and a red flashing warning light. The LED graphic display screen is a rectangular flat box-shaped LED display screen, and the warning light is located on the outer surface of the LED graphic display screen; The P data processing and transmission chip circuit is a circuit board with the functions of processing the data transmitted by the D data processing and transmission chip circuit of the solar floor lamp, controlling the on-off warning light to blink on or off, and driving the LED graphic display screen for graphic display, and having the functions of wireless data transmission with the D data processing and transmission chip circuit of the solar floor lamp and transmitting the data to the traffic control center through the Internet; P solar photovoltaic cells and P charging and discharging cells are devices for supplying power to P data processing and transmission chip circuits, LED graphic display screens and warning lights.

The solar LED display screen is arranged on the right roadside along the road driving direction, and the solar LED display screen faces the road driving direction; The solar floor lamps uniformly distributed in an array are called floor lamp arrays, and several floor lamp arrays are arranged and buried at intervals on the road surface ~ meters away from the front of the solar LED display screen along the road driving direction.

## 6. Conclusion

When the road surface freezes, the temperature and humidity sensors of the solar floor lamp will process the freezing critical data collected from the ground through the D data processing and transmission chip circuit, and the D data processing and transmission chip circuit will turn the LED lamp of the solar floor lamp from green to red to emit flashing warning red light, and at the same time, the warning data will be transmitted to the solar LED display screen, which will be processed by the P data processing and transmission chip circuit of the solar LED display screen, and the LED graphic display screen will be turned on to send a graphic warning to the driving vehicle, and the warning light will be turned on to send a flashing red warning, and the data will be transmitted to the traffic control center through the Internet.

The measurement system adopts high-performance core hardware system, which simplifies the design of peripheral interface circuit and improves the cost performance of the system. The designed system has high detection accuracy, can meet the use requirements, and the system runs stably and reliably. ZigBee technology is selected to realize wireless sensor network, which improves the flexibility of the system. This new detection method of highway pavement icing designs a new type of highway pavement icing sensor platform, which scientifically uses the changes of three parameters, namely temperature, pavement vibration information and pavement resistance to reflect the pavement icing condition, thus avoiding false detection to the greatest extent and improving the detection accuracy. The facility device sends out red light and graphic warning of road freezing according to freezing critical data collected from the ground in real time, so that the expressway can issue warning of road freezing in real time, and the harm of road freezing to passing vehicles is reduced.

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