

Technical description of the weather controlled road in the south-eastern Finland

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Abstract

Variable speed limit signs and information boards are being used on the experimental motorway section between the towns of Kotka and Hamina on the Southern coast of Finland. Thirty-five variable speed limit signs and five info signs are controlled according to weather and road surface conditions. The aim of the experiment is to make traffic more manageable and to improve traffic safety.

The weather and road conditions are observed with two automatic road weather stations. One is situated at a place where the motorway is close to the sea and the other one is placed inland where the climate is different. The road weather stations include sensitive elements that measure road condition, rain, temperatures, visibility etc.

The variable signs are controlled by their own dedicated equipment. The central unit of road weather information system collects information from the road weather stations, analyses the road conditions and recommends speed limits on the basis of this information. The recommended speed limit is transmitted to the traffic signs' control logistics equipment. The central unit of road weather information system also analyses data for the information boards. The variable speed limit signs and information boards can be controlled also manually from the technical building at the side of the motorway, the maintenance station at Kotka or the road weather monitoring centre at Kouvola. These sites are connected by fixed leased lines.

Variable speed limit signs are gathered in six groups. The speed limit recommendations are calculated for individual groups and the signs in one group always have the same speed limit. It is also possible to control each group manually and separately. All five information boards are independent units. The speed limit signs use optic fibre technique and the info signs use LED technique besides. All the signs have both data and electric wiring and are connected to the technical building with standard industrial bus.

1 Weather controlled road

Kotka-Hamina weather controlled road is a 14 kilometres four-lane motorway section on the south coast of Finland. The road section is in an area where the weather changes frequently. The temperature varies above and below zero degrees Celsius in winter time. It is also snowing, wet snowing and even raining regularly. The experimental road section has 36 variable speed limit signs and five information boards. The variable signs are controlled automatically on the basis of the road and weather conditions. The aim of the experiment is to make traffic more fluent and improve traffic safety. The planning of the weather controlled road started at the beginning of 1992. The system was ready in November 1994. The total investment costs of the system were about 8,3 million Finnish marks (1,8 million \$) and the estimated maintenance and data communication costs are 350 thousand Finnish marks (77 thousand \$) per year. The effects of the weather controlled road are and will be closely studied. The aim of this study is to evaluate the effects of the system on drivers' behaviour, traffic safety and maintenance of the road. The results will be used in making a decision whether the system can be applied to other highways.

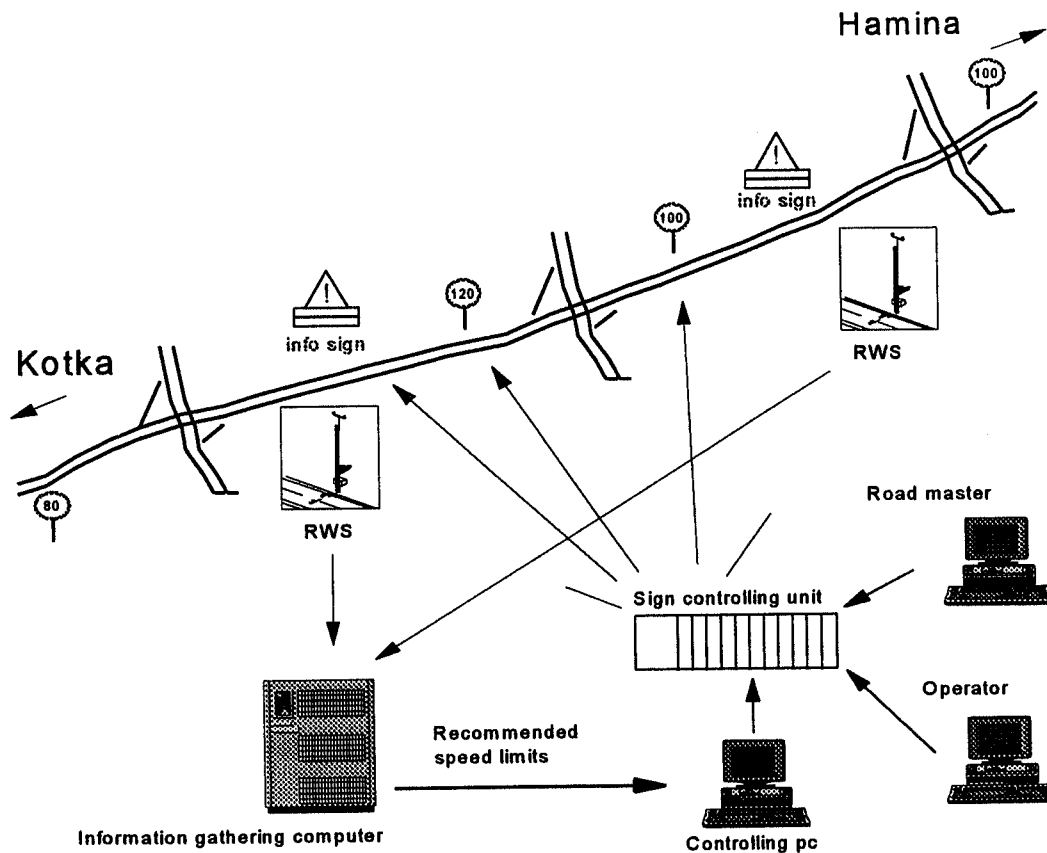


Figure 1. Weather controlled road, experimental road section, 14 km

2. Collecting and analysing the road weather information

The weather and road conditions information is collected from two automatic road weather stations in five minutes intervals. The collecting computer has weather information software and Oracle database. The operating system of this computer is Unix. The two road weather stations are connected with direct data lines to the collecting computer. The stations have sensors for air temperature, road surface temperature, ground temperature, humidity, precipitation, wind and road condition. One of the stations has also sensors for the visibility and type of the precipitation. One of the stations is located by the sea and the other one inland. The micro climates are slightly different in these two spots. The both stations have four sensors for the road conditions, one for each lane. The collecting computer stores and analyses the information collected and makes recommendations for the speed limit signs and information boards. The variable signs are controlled by the computerised logical devices. The sign controlling unit reads the recommendations from the hard disk of the collecting computer. The hard disk in the collecting computer is shared with tcp/ip -based NFS-software. The controlling unit includes one OS/2 -workstation which has NFS connection the shared disk. The variable signs are connected to the controlling unit with the standard industrial bus. There is a special technical building for the computers and logical devices by the motorway. The technical building has versatile data communication connections for the stations, signs, surveillance and remote access.

3 The signs and the sign controlling terms

The speed limits vary between three categories (80, 100, 120 km/h) in summer time and two categories (80, 100 km/h) in the mid winter time. The normal "good" road conditions speed limit is 120 km/h in summer and 100 km/h in winter. The information boards display information about the current weather and road conditions and also other information, for example about the road works. If there is nothing to warn about then the temperatures of the air and road surface are displayed. The road section is divided into six different controlling zones. The speed limits and information can vary independently from in these six zones. The terms which decide the recommendations for the signs are stored in the database of the collecting computer. The terms are easy to configure and alter if needed. The collected road weather data can be compared with each other and with the constant values. Also the trends of the sensor values can be monitored by the terms. At present the weather and the road conditions are divided into three different categories; good, bad and other conditions, 120, 80 and 100 km/h

accordingly. The most important sensor values for the terms are the road condition, precipitation, visibility and wind. The sign controlling unit (the central logical equipment) reads the recommendations and changes the speed limits and information on the signs if needed. When the conditions are getting worse the signs are changed immediately. When the conditions are getting better a 15 minutes delay is used. The reason for the delay is that the signs will not change all the time in the boundary conditions. If there are no recommendations (an error situation) the sign controlling unit changes the speed limit signs to the 100 km/h and displays no data on information boards.

4. The sign controlling unit and the sign bus

The sign controlling unit consists of the central logical equipment and the controlling OS/2 -workstations (PCs with OS/2 operating system). One of the three OS/2 -workstations is connected to the data collecting computer. It reads and pasts the speed and information recommendations to the logic equipment. It is possible to control the speed limit and information signs manually at every workstation. The three workstations are connected with the serial line connection to the logic. One of the workstations is in the technical building, one in the local road master's office and one in the road weather monitoring centre of the road district. The connections to the road master office and weather monitoring centre are direct lines above the tcp/ip-network. The software in the logic equipment controls that there are no inconsistent information on the signs. Every change to the signs is written to the log file with a time stamp.

The variable message signs and the central logic are connected to each other with standard industrial bus. The bus itself is a copper paired cable, it starts from the logic and circulates every sign in the bus. There is a terminal resistance at the end of the bus. The meaning of the resistance is to make bus to look like never-ending. The communication in the bus is serial line communication (RS-485) and the speed is 9600 bits/s. The central logic asks in turn every sign if there is any need for communication. If there is, the sign communicates with the central logic and gives the control back to the logic. Every sign in the bus "hears" all communication but they communicate only on their own turn. The central logic has always the control of the communication in the bus. With this method the logic can put priority for communication. The logic communicates all the time with the signs even if there is no need to change speed limits or information. The state of the signs is known continuously. At present there are five independent

busses connected to the logic. All five information boards are in their own bus and other four busses have only speed limit signs. If the cable comprising the bus is damaged, the whole communication in the bus is prevented in practice. The maximum length of the bus without any repeater devices is about 1,5 kilometres and with repeaters several kilometres. Two most distant busses are connected to the logic with fixed lines modems and RS-232 connection. The busses themselves are also there in RS-485 standard. Of course there are converters which convert the RS-232 -communication to RS-485 and vice versa.

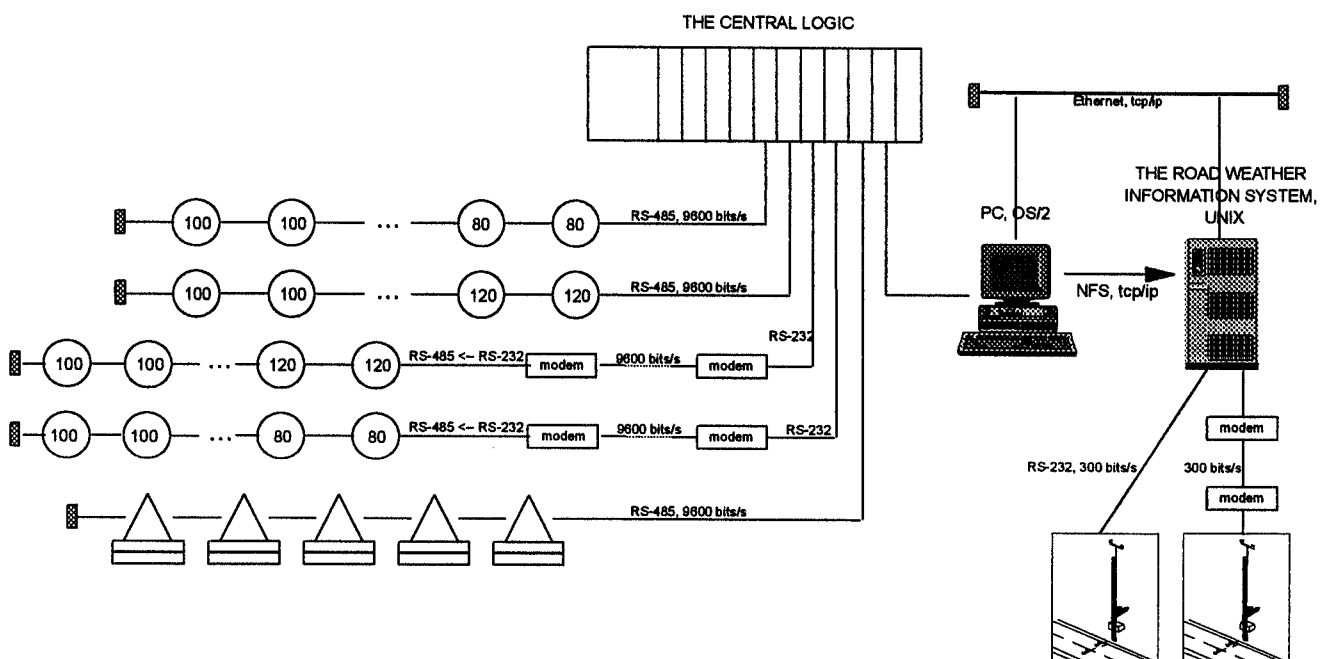


Figure 2. The central logic, the signs and the busses

5. The information boards

The information boards consist of two parts. The upper part is a warning sign and the lower part is a two-row text part. The upper part is made with optic fibre technique and the lower part with LED-technique.

In the upper part the optic fibre bunch is given light to the other end. In the other end of the fibres there are white or red lenses which are fastened to the front board of the sign to form the wanted figures. The source of the light is a halogen lamp. The light source is backed up with a spare lamp. The benefits of the optic fibre technique are the durability (no moving parts) and

the visibility of the signs. Each figure needs its own optic fibre bunch. There are three possible warning figures in the sign; warning, road work and slippery road.

The two text rows in the info sign use LED (light-emitting diode) -technique. The LEDs are controlled by the microcomputer integrated to the sign. Both text rows have ten characters. With these 20 characters it is possible to display information about temperatures, road condition, winds, road works etc. All the texts are pre-programmed to the signs. There can be 255 different texts for each line. It is possible to change and program new texts to the signs. Every character has 5*7 pixels. The size of the one character is 16*22,5 cm. Every pixel in the character is made of ten LEDs. A LED is very durable. The estimated life time is millions of hours! (one year is 8760 hours) The benefits of the LED-technique are the durability (no moving parts) and the good visibility. However the LED-technique is still quite expensive.

The info signs have a heating and ventilation system. The inside temperature of the sign should be between +5 and +50 degrees Celsius. The needed heating and ventilation is controlled by an autonomic thermostatic system. The signs have a self diagnostic system which monitors the operation. It enables the spare lamps if needed, controls the correctness of the displays and alarms the faults to the central logic. The control-logic part in the sign handles the communication to the central logic. It receives the control commands and passes them to the microcomputer of the sign. It also sends a feedback information (confirmations, state of the sign, alarms) to the central logic. If the sign does not get any control commands from the central logic it shuts itself down after one minute.

6. The speed limit signs

The speed limit signs are made with optic fibre technique like the upper parts of the info signs. Also the speed limit signs have a self diagnostic system which monitors the operation of the sign and the correctness of the display. The speed limit signs are able to show three different speed limit figures on the sign; 80, 100 and 120 km/h. The logic part handles the communication via bus to the central logic. If the sign does not get any control commands from the central logic it shuts itself down after one minute.

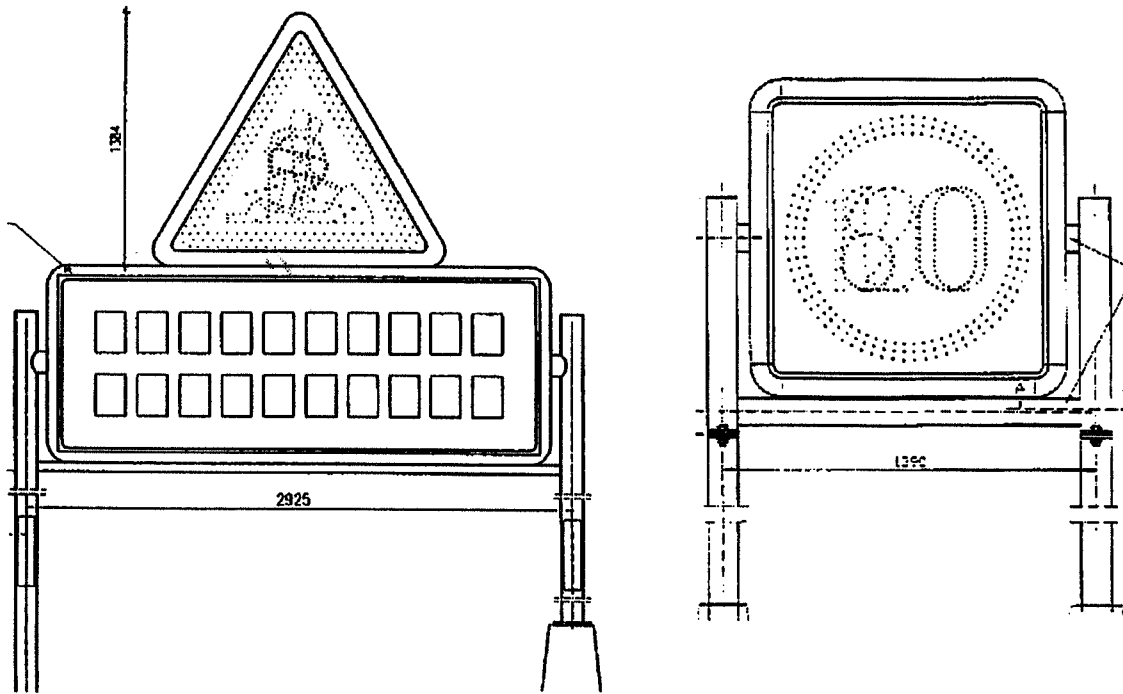


Figure 3. The information board and the speed limit sign