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Design and Analysis of Variable Message Sign Pole Structure

[1]n .R. Unecha, [2]s .S. Jagtap, [3]r .A.Ghatge, [4]s .S. Manjare, [5]s .M. Patil.
[1, 2, 3, 4,5]Department of Mechanical Engineering, RSSOER Maharashtra, S. P. Pune University, India
Corresponding Author: n .R.Unecha

Abstract : *This paper covers the geotechnical design of variable message sign pole (real time traffic warning sign pole). Traffic structures include sign bridges, cantilevered signs, signal supports, strain poles, illumination, and camera poles. The major cities in the world possess good modern road networks with huge everyday traffic similar to any developed countries like USA and Europe. Currently, these VMS display only general static information for testing their reliability under local conditions and to familiarize drivers with this technology. Local traffic authorities are currently addressing the blocking problem by planning a massive mass transport system of underground networks. The local authorities are also planning to adopt the Intelligent Transportation System (ITS) as a possible immediate means for mitigating the blocking problem. Variable Message Signs (VMS) is a ITS technique newly introduced in the country to inform the drivers about the instant traffic conditions and to advise them how to deal effectively with it. Usually, such effort strenghten traffic operations and improves safety. The main objective of this paper is to appraise the response of the drivers to VMS when used for conveying messages related to immediate traffic conditions and make the VMS structures strong enough to withstand severe conditions*
Keywords : *VMS, Structure, ITS ,safety, strong.*

I. Introduction

Several studies were conducted in different countries to measure the impact of variable message signs by conducting field observation of the drivers' response to VMS and also through questionnaires to measure the drivers' intended response to VMS suggestions and information. A recent assessment conducted in Missouri to analyse the drivers' response to VMS along rural freeway revealed that 94% of the surveyed drivers claimed that they will follow with the instructions and suggestions of VMS. A variable message sign (VMS) is a traffic control device whose message can be changed manually, electronically, mechanically, or electromechanically to provide motorists with information about traffic blocking, traffic crashes, maintenance operations, adverse weather conditions, freeway conditions, organized events, or other highway features the systems will meet following objectives:

- Smooth and continuous traffic flow.
- increase road safety.
- actual time traffic information and guidance to users.
- Emergency backing round the clock.
- Alerts for uneven road and weather conditions.
- Reduced journey time and trouble.

II. General Understanding of the Variable Message Sign Pol

1) The VMS sign boards during their trips were also asked whether they understand the VMS. Overall, 92 percent drivers who noticed the VMS sign boards declare that they understand the boards
2) Emergency table analysis reveals that there is a important relationship between driver's general understanding and two personal variables (age and education).
3) Log it models shows that negative coefficient of age group confirm that drivers having age above 40 years are less likely to understand sign boards.

III. Methodology

1) The study approach adopted includes the evaluation of earlier study reports, research papers and existing proposed development in ITS both in India and abroad, design and conduct of key surveys, essential data collection from Delhi Traffic Police office, scrutinize findings of the collected data.
2) A number of statistical analysis techniques were used to analyse relationships between drivers and trip characteristics and with the ITS modules such as advanced parking system, traveler information, and variable message sign regarding their understanding and usage of the system.

3) Fundamental human behavior remains constant. No matter how we turn over the problem road user behavior vs. road design, the road owner naturally observes user behavior based on existing road design. Therefore the only effective cure for road issues is upgrading the road environment.

4) VMS messages, display techniques and placement of VMS are critical. Delivery of accurate current travel time information via VMS is a important feature in credibly managing any crowded and costantly changing motorway environment.

IV. Vms Design Process

The design process presented here displays the steps needed for proper VMS deployment. It does not, however, take every possible unreliable values into discussion. The designer should have proper judgment for each step for a successful positioning.

1) Collect introductory data required for the proposed variable message sign deployment.
2) Determine the type of VMS.
3) Determine suitable passage placement for VMS implementation.
4) Collect specific data from the site required for the proposed variable message sign location.
5) Select the site requirement for design of VMS pole structure.
6) Determine the container placement for the VMS.
7) construction of underground infrastructure.
8) Determine the broadcasting medium used for the proposed location.
9) Reanalyze steps 4 through 8 until final design is complete.
10) Begin the process to establish electrical supply for the proposed location with the local power company. This should be done early in the design process to establish an acceptable electrical service location.
11) Determine the construction details needed for the proposed design, details which needs to be modified, create to provide a complete construction plan.

V. Statistical Analysis

Statistical analysis is also used to test the difference of the diversion rate before and after a message is activated. It is expected that the vehicles will take an alternative route instead of the congested road and the number of exiting vehicles on off-ramps would change immediately after a warning message. Messages can have two different influences on different exits, one is to attract diversion, and the other is to repel diversion. That is to say, the diversion rate after a message should significantly increase immediately after a message warning of a special event ahead on the road. On the other hand, the diversion rate should significantly decrease immediately after a message warning of blocking or an incident on other roads. So the data were grouped into two groups according to the effect of the message. Therefore, under these two situations, the void assumption that the mean of diversion rate in 10 minutes doesn't change before and after the message is tested.

VI. Data Collection

Data collection required for VMS installation is broken into two areas: introductory data collection, and on-spot specific data collection. Under introductory data collection, the following information will need to be obtained to determine the area, corridor, and type of the variable message sign.

- The purpose of the VMS.
- Type of information to be displayed on VMS.
- Substitute route changing points.

Under on-spot data collection, the following information should be obtained to determine the exact location of the variable message sign.

- Base calibrating with local freeway network linked to the section under analysis for the VMS.
- Existing freeway horizontal alignment.
- Freeway vertical information.
- Existing sign inventory.
- Location of power along freeway section.

VII. Vms Site Selection And Placement

1) Substitute Route Diversion Points:- In an metropolitan freeway network, VMS should be located in advance of substitute route access points on the network to allow motorists to take action in response to the message on the sign. In an metropolitan setting there are typically many other signs that compete for motorists' attention, and VMS should be placed for maximum visibility and impact. The minimum distance a freeway VMS should be placed before to an access point is one mile. On an arterial freeway section, the distance may vary based on issues such as speed limits, local factors, and right-of-way constraints.

2) Existing Horizontal Arrangement Data: - To ensure proper viewing of the VMS, message sites must be located on tangent freeway sections. The introduction of even minor curves along the freeway can impact visibility. Current VMS technology limits a pixel's cone of visibility to only a few degrees. Because of this, minor changes in the horizontal arrangement may make the message unreadable. The designer should look for sites that are located on tangents and allow a motorist at least 1000 to 1100 feet of clear sight distance to the sign while traveling 60 mph or faster. If the motorist is traveling between 40-50 mph, the minimum distance needed should be 500 feet.

3) Existing Vertical Arrangement Data: - Vertical arrangement along the freeway also impacts the visibility of the VMS. The cone of visibility limits the visibility of the VMS in these areas. If there are a limited number of potential locations available, an upward grade is desirable. Ideal site locations along freeway sections within 1% grade or less are desirable. VMS should not be placed along grades exceeding 4%.

4) Existing Sign and Traffic Control Inventory: - VMS should not compete with other existing VMS signs or interfere with other traffic control devices. The designer must take inventory of all signs and traffic control devices along a freeway section to properly place the VMS. Based on this inventory, existing signs may need to be moved to accommodate proper VMS placement. On the freeway, the minimum distance between Type 1 guide signs and a VMS is 800 feet. On arterial streets the distance allowed between Type 1 signs and a VMS is approximately 400 feet. Since the VMS signs are typically installed in elevated positions care should be taken by the designer to also identify possible conflict with the VMS blocking other existing signs or traffic control device.

5) Location of Power along Freeway Section:-Locating existing power along a freeway section helps a designer understand how difficult it might be to power a potential VMS site. It is desirable to locate the cabinet and electrical service as close together as possible. All power service locations require approval from the utility company before to installation.

6) VMS Height Requirements:-Per the Manual on Uniform Traffic Control Devices (MUTCD), the minimum distance between the crown of the freeway and the bottom of a freeway guide sign is 18 feet. This takes into consideration future pavement overlays that might raise the freeway surface. On freeway VMS the 18-ft requirement does not apply to the sign itself, but rather to the lowest point of the structure. The 18-foot minimum is also used for arterial VMS that are mounted on cantilevers.

7) Safety Considerations: - A site must be designed to allow for safe maintain and operation of the VMS and its controller cabinet. To address safety issues the following question should be asked:
- Does the site allow safe and easy access for maintenance vehicles?
- How exposed will maintenance vehicles and manpower will be to live traffic while at the site?
- Can workforce access the controller cabinet without having to use the freeway shoulder?

VIII. Determination of Vms Type

Before to locating VMS along a freeway section, some engineering decisions are need to be made, and VMS type selected. The type of decisions that a designer must address before to selecting a location include:
- The purpose of the VMS – Will the VMS serve the general traveling public, a special event generator, or is it needed for upcoming construction?
- Type of information to be displayed on VMS – Will the VMS be used for only one message that is blinking on or off, a few select messages needing limited lines, or a wide range of information displayed? The type of information to be displayed will determine if a character, line, or full matrix VMS is necessary.
- Type of VMS technology – What advantages and disadvantages to the technology being installed will need to be considered or accounted for in the design.

IX. Ifferent Types Of Corrosion In Vms Pole

Pitting corrosion: This can occur with mild steel immersed in water or soil. This corrosion occurs due to the presence of moisture or constant exposure to substitute wetting and drying.

Fig 1.1 Pitting corrosion.

Crevice corrosion: The oxygen content of water trapped in a crevice is less than that of water which is exposed to air. Due to this the crevice becomes anodic with respect to surrounding metal and hence the corrosion starts inside the crevice.

Fig 1.2 Crevice Corrosion.

Bimetallic corrosion: When two dissimilar metals (for e.g. Iron and Aluminum) are joined together in an electrolyte, an electrical current passes between them and the corrosion occurs.

Fig 1.3 Bimetallic Corrosion.

Stress corrosion: This occurs under the simultaneous influence of a static tensile stress and a specific corrosive environment. Stress makes some spots in a body more anodic especially the stress concentration zones which is the anodic part and it corrodes to make the crack wider.

Fig 1.4 Stress Corrosion.

Fretting corrosion: If two films coated with oxide or rusted surfaces are rubbed together, the oxide film can be mechanically removed from high spots between the contacting surfaces. These exposed points become active anodes compared with the rest of the surfaces and initiate corrosion. This is a common type of corrosion mechnical components.

Fig 1.5 Fretting corrosion.

X. Types of Failure in Vms

BucklingFailure: -When a structure is subjected to compressive stress, buckling may occur. Buckling is characterized by a sudden sideways deflection of a structural member. As an applied load is increased on a member, such as a column, it will ultimately become large enough to cause the member to become unstable and it is said to have buckled.

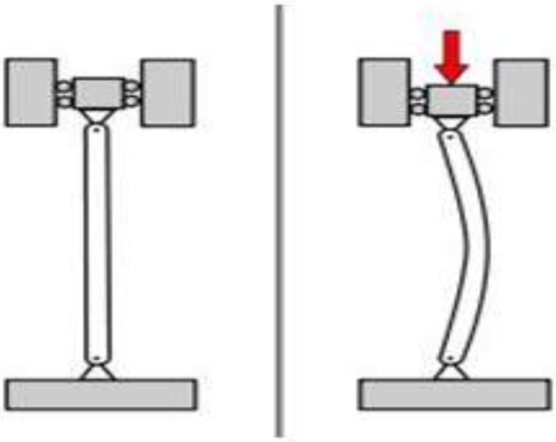


Fig 2.1 Buckling Failure.

Ductile Failure: - Ductile fracture, extensive plastic deformation takes place before fracture. Rather than cracking; the material "pulls apart," generally leaving a irregular surface. The basic steps in ductile fracture are crack formation, crack propagation, and failure, often results in a cup-and-cone shaped failure surface.

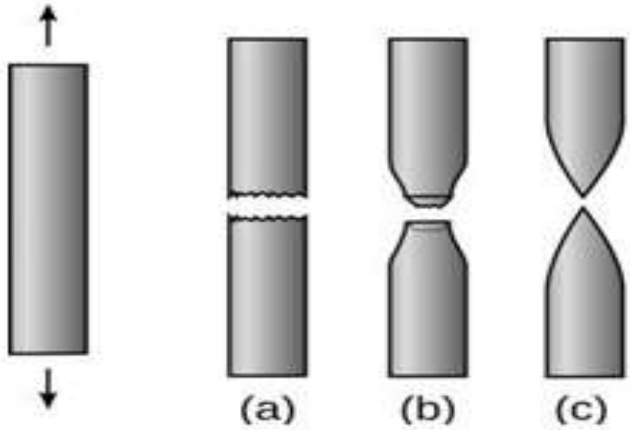
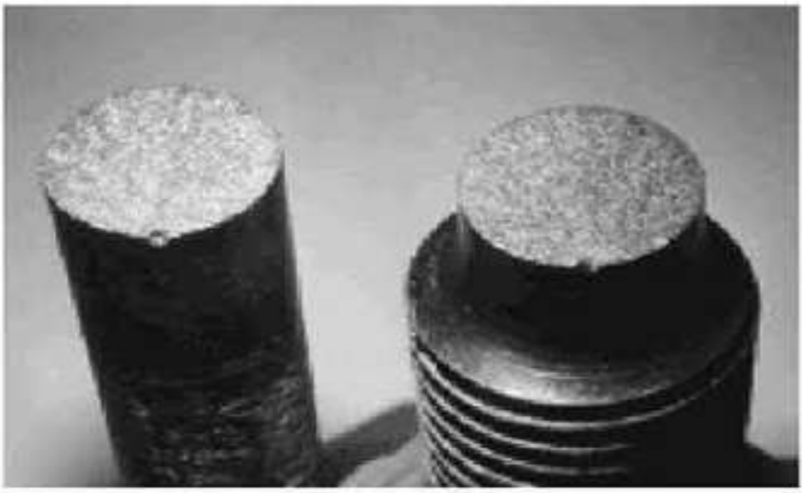


Fig 2.2 Ductile Failure.

Brittle Failure: - In brittle fracture,no apparent plastic deformation takes place before fracture.In brittle crystalline materials, fracture can occur by *cleavage*.

Fig 2.3 Brittle Failure.



Impact Failure: - An impact is a high force or shock applied over a short period of time when two or more bodies clash. Such a force or acceleration usually has a greater effect than a lower force applied over a proportionally longer period. The effect depends critically on the relative velocity of the bodies to one another.

Fig 2.4 Impact Failure.

Creep:- It is the tendency of a solid material to deform permanently under the influence of mechanical stresses. It can occur as a result of long-term exposure to high levels of stress that are still below the yield strength of the material.

XI. Failure Responses

	Types of Failure	Responses to Failure
i.	Where mains power is lost	The entire display area of the VMS
	to the SC or the VMS itself.	will be completely blanked. Create a
		log in the SC specifying power failure
		for affected device(s).
ii.	Where the communication	The entire display area of the VMS
	link to either of the SC's	will be completely blanked. Create a
	physical serial ports is lost	log in the SC detailing which serial
	or adversely affected.	interface was affected.
iii.	Where an established	The entire display area of the VMS
	communication link over	will be completely blanked. Create a
	TCP/IP is lost or	log in the SC detailing the nature of
	interrupted.	the link loss.
iv.	Where the communication	The entire display area of the VMS
	between the SC and the	will be completely blanked. Create a
	VMS itself is lost or	log in the SC detailing the specific
	adversely affected.	type of communications failure to the
		VMS sign.
v.	Where internal faults are	The entire display area of the VMS
	detected within the SC	will be completely blanked. Create a
	and/or VMS itself, i.e.	log in the SC specifying the nature of
	watchdog timeout etc.	the failure.
vi.	Where 10 percent or more	The entire display area of the VMS
	of LEDs in either the	will be completely blanked. Create a
	pictogram display and/or	log in the SC of the type & extent of
	the text display elements of	the LED failure(s).
	the VMS have failed OR	
	have become faulty* OR are	
	affected to the extent that	
	the resultant displays may	
	be confusing to the public.	

XII. Save the Travel Time

Travel Time Savings the chief objective of VMS is to divert traffic flow when an accident happens ahead and by encouraging vehicles to use alternative routes. Therefore, the travel time saving for drivers is one of important benefits of VMS systems. Effectiveness Travel time saving can be measured as the difference of travel time before and after installation of VMS on the same freeway sections that is affected by the VMS.

The situations under both incident and non-incident situations and peak and non-peak periods are considered respectively. Empirical data from curve detectors are used to calculate travel time on freeway. Traffic occupancy and flow data are determined from the curve detectors on the section, and flow, speed and density in 5 minutes time slices throughout the same section are assumed to be homogenous. Effective vehicle length is 22 feet. Speed is free flow speed (60 miles/hour) if occupancy is below 10%, and 5 miles/hour if occupancy is above 80%, and calculated using the Q/K=V relationship otherwise.

XIII. Reduction in Delay Time

Vehicle-hours reduction per incident is measured to evaluate the benefit of VMS on reduction of total delay. Input and output analysis is used to calculate the total delay of vehicle hours. When an incident happens, the capacity of road reduces and the queue begins to stack at the bottleneck when the arrival rate is over the reduced capacity. The vertical difference of two curves is the length of queue at a specific time and the horizontal distance between two curves is the delayed time in queue. Therefore, the total delay can be calculated as the area between the input and output curve.

VMS provides dynamic information about incidents to drivers and increases the rate at which drivers divert at the exits before incident location. Theoretically, after VMS is turned on, the arrival rate decreases (assuming the VMS is warning of a message ahead on the same road).we can see the duration for queue dissipation reduce. So both the queue duration and the number of vehicles involved in the queue are less than without VMS, which results in reduction of the total vehicle-hours delay caused by incident. Therefore, the difference of the area between the input and output curve is the reduction of total delay in vehicle-hours.

XIV. Conclusion

Variable Message Signs (VMS) are digital road signs used to inform car drivers about real-time traffic conditions. The signs are often linked to a manned control center via a local network or a radio link. Variable message signs (VMS) are an essential part of Intelligent Transportation System. The aim of using VMS is to provide drivers with mandatory and/or advisory information at the roadside. VMS can be used for many different purposes with the

potential benefits of reducing car drivers' stress, travel time and increasing traffic safety. VMS may ask drivers toincrease or decrease the travel speed, change lanes, divert to a different route, direct to the available parking space, or simply to be aware of a change in current or future traffic conditions by providing information. The information will help to assist drivers in selecting appropriate routes avoiding blocking and to reduce drivers' anxiety.

The benefits of the signs in general are difficult to measure. VMS are often used to inform drivers of blockingahead , incidents ahead and unexpected delays and can as such reduce drivers' stress. Signs can be particularlybeneficial where drivers can be informed of substitute routes or park and ride sites to avoid further delays, but this may require the VMS to be an essential part of a wider and more costly traffic monitoring system. One major study suggests that drivers would like to see VMS used more. the facts is,VMS are not likely to distract drivers if designed properly. Violations of speed limits are expected to reduce where 'SLOW DOWN' signs are put up. The main challenge of implementation is cost.However, by reducing the number of stationary road signs it is suggested that properly designed VMS can reduce negative aesthetic impacts.

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