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Enhancement of Flooded Road Smart Warning System Project With Logan City Council, Queensland, Australia.

Gaurav Goswami[1]

[1]*Master of Environmental Engineering & Pollution Control, Griffith University, Queensland, Australia.*

Abstract — *An enhancement of flooded road smart warning system project (FRSWS) incorporates the most suitable way of arranging the flood warning sign and its components such a way that it can prevent unintentional access of motorist in flood water in Logan City Council shire, Australia. This project eliminates the limitation of the old warning system and provides an excessive advantage to the motorists in order to avoid their unintentional access in the flooded road. Many people in the world try to cross the flooded road without having the actual awareness of the depth of water, which turns into an extreme fatality. The purpose of the enhancement of flood warning system is to design the flood warning sign and its components in the most effective way where people can be immediately notified in case there is a flood. The flood warning sign components which include the floodway sign and accessories, the position of the floodway sign on the road, LED matrix board presenting "ROAD FLOODED" text, consideration of dust and waterproofing factors for the control system and trenching for cables. These five areas of this project needed to be enhanced and standardized in order to maintain the equality and effectiveness to fulfill the real purpose of this project, in addition to that, it can save as many lives as possible if it would be implemented in the flood-prone zones.*

Keywords- *Trenching, waterproofing, dustproofing, LED warning text, Logan City Council, MUTCD, TMR*

I. INTRODUCTION

Australia is a culturally diverse country, but it is also varied in terms of severe weather conditions-experiencing extreme storms, bushfires, and flood; especially during summertime [1]. Every year, flooding in Australia cost more than A$900 million, and the most severe flood that Australia has ever experienced was 2010-11 flood, which estimated over A$6 billion [2]. In Australia, New South Wales, and Queensland are the most affected states of flood-related fatalities, which is more than 70% of overall Australian statistics [3]. According to the 2015 report by Anon, over 50,000 people lost their lives by crossing the flooded road in the last decade [4].

The main responsibility of any government council is to make their people aware of the hazard situations, whether it is traffic condition or extreme weather warning. The flooded road smart warning system project (FRSWS) was a multidisciplinary project initiated in 2016 by Logan City Council (LCC) collaborated with Griffith University, Queensland, and the intention of avoiding inadvertent entry of drivers who risk their lives in floodwaters. Griffith University offered Industrial Affiliates Program (IAP) to their final year students who want to collaborate with industries relevant to their studies and seek the real industrial experience. My role for this project is to eliminate the limitation of the old warning system and design a new warning system and its components according to the Australian standards, and my first stage of this project was to research about suitable Australian standards which are applicable to this project. In the second stage, I had to design a new warning system and components while considering the Australian standards.

Many flood-prone zones are not having enough facilities to warn people about the floodwater, but this project of LCC was enhanced from simple warning sign system to the digitally advanced warning system, which includes automated amber LED warning system in which an electronic sensor automatically tripped by a float switch when water reaches a certain level, as a result, it triggers amber LED warning text. By using this kind of LED warning over the flooded road warning sign, people can get informed better about what is coming next on their way. In addition, the first enhancement involved with 3G network and email to sending alerts to the site officer when a particular site has been flooded [5]. The installing cost of FRSWS is $20,000 for a site in Australia, and by the June 2018, LCC has been installed over 40 signs in different locations of the council.

II. OLD LCC FLOOD-WARNING SIGN & STANDARDIZED SIGN

In Australia, Traffic Main Road (TMR) department provides the generalized design of signs which is predefined according to the Australian standards, but many councils have either simple or different specification signs. Many warning signs are not very effective on the roads or some standardized warning signs are not technologically advanced when it comes to saving people's lives. While working on this project, I have concluded that the old LCC sign design was not very effective, as shown in Fig. 1 below and also it needed to be standardized.

Fig. 1. Old LCC warning sign system.

During the research, I have found that the Manual of Uniform Traffic Control Devices 1742 (MUTCD 1742), which is an Australian standard for road signs, and it is made of different signs depends on the actual road purpose, for instance, regulatory sign, warning sign, guide sign, and hazard markers. The traditional flooded road warning sign that defined in MUTCD 1742 the Flooded Road Smart Warning sign falls under the Guide sign and it is denoted as G9-21-1 as illustrated below in the Fig. 2 [6].

Fig. 2. Traditional road subject to flooding G9-21-1 sign.

The traditional flooded road warning sign is combined with a depth indicator sign. The main purpose of the depth indicator is to make people aware of the depth of flood water, and it would indicate that flood water is beyond the limit to cross the road, however, sometimes people either misjudge the depth of water or deliberately trying to cross the road at a high-risk, which resulted in a catastrophe. Therefore, these types of flood warning systems are not very effective and hence, people accidentally jump into an extreme situation which leads them to adverse circumstances.

III. ENHANCED FLOOD-SMART WARNING SIGN

In the new LCC smart warning sign, the modifications have been occurred by considering the Australian and New Zealand standards and TMR specification. During the research, I have considered some modifications in the system design which would be very efficient in terms of road safety. The modifications took place in sign design, and therefore people can notice the warning sign from sufficiently far distance even during the heavy rain and storm, which leads them to escape from the flood zone.

During the first phase of the project, I have defined that LED flashing lights would be more effective in order to make people aware of what is coming on their way. In the LED flashing sign, as soon as the water reaches to a maximum predefined level and the float switch sends a signal to the microprocessors, two amber LED lights start flashing in the loop as shown as Fig.3 below. The flashing lights sign was examined at LCC Marsden depot with 700cd luminous intensity LEDs with a good weather condition. Despite the sunny day at the site, the system worked very effectively, and the LEDs had given sufficient performance even at a far distance as described in AS 1742.2-2009 MUTCD Part-2 [7]. With this kind of system, drivers can able to brake their vehicles at a fair distance behind the actual flood zone, which can save their lives.

Fig. 3. Flashing lights demonstration at LCC site.

However, in the second phase of the project, an LED matrix board representing 'ROAD FLOODED' text above the G9-21-1 was also a possible idea which can be more effective as well. In the early stage, the council members have opted the round flashing warning sign instead of the LED warning text, but they finally approved to the LED matrix board. The final warning sign is as shown in Fig. 4 below with the amber LED warning text in matrix board has been placed above G9-21-1 sign which plays a critical role in saving people's lives than the traditional warning sign system.

Fig. 4. LED 'ROAD FLOODED' text matrix board on G9-21-1 sign at the actual site [8].

On the other hand, from the electronic side of this project, Arduino microprocessor comprises with the 2G network, which was later enhanced to the 3G network and email system, sends a text message to the On-call officer whenever the road is flooded and warning has been activated [8].

IV. SIGN POSITIONING ON THE ROAD

After producing the standardized sign and its components, the main issue was to define the ideal position of signs on the road. During the research, I have discovered that the flooded road signs such as warning sign (W), Guide sign (G) and depth indicators should be used as a combination and also at a certain distance with respect to one another, which is very important for commuters to get sufficient warnings at proper distance from the hazard zone. If the sign were not posted at a certain distance from one another, commuters would not have enough time to break their vehicle before the hazard zone and end up with a disaster. The appropriate layout of floodway sign positioning is described in MUTCD AS 1742.2. According to the speed zones, signs should be placed on the road at a certain distance, which is shown in Fig. 5 below [9]. The floodway sign W5-7-1 or W5-7-2 are warning signs which must be placed 80-120m advance of the sign G9-21-1 for the speed zone of <75 Km/h (which is represented by distance A in Fig. 5 below), while for the speed zone of 75-90 Km/h, the distance should be 120-180m apart from the advance warning sign G9-21-1 [10].

For distance B, on the other hand, G9-21-1 sign should be at 50m apart from the depth indicators for the speed zone of <75 Km/h, while for the speed zone of 75-90 Km/h, the advance warning sign should be 60m apart from the depth indicators. By employing these distances on the road to build the signs, people can easily brake their vehicle at a fair distance apart from the flooded road. Moreover, by employing the smart warning system for the potential flooded roads, many councils and government municipal corporations can save many lives on the road [10].

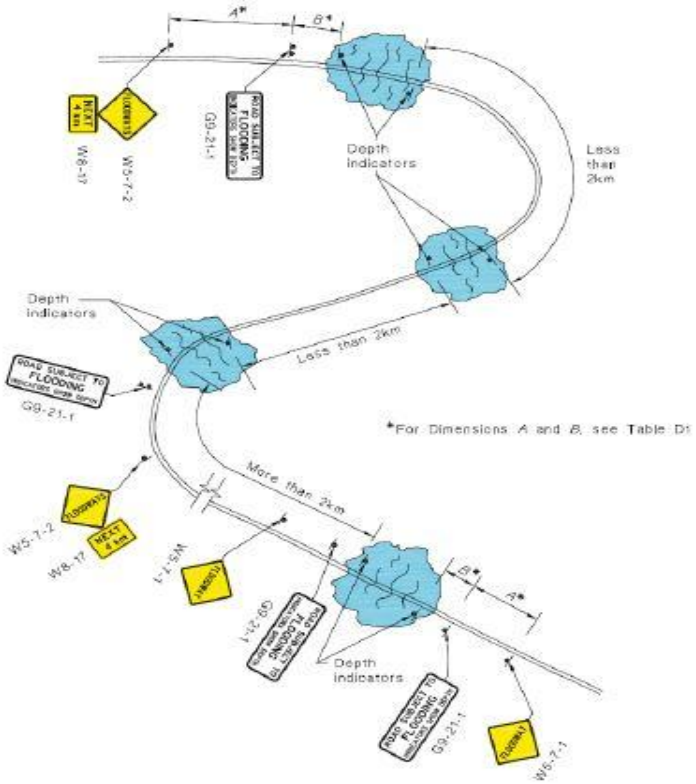

Fig. 5. Warning sign distances according to AS 1742.2 – 2009 [9].

V. DESIGN AND WEATHERPROOFING THE CONTROL HOUSING BOX

The design of control housing box is extremely important in the smart warning system because it possesses microcontroller, the antenna of telecommunication, batteries and other electronic components, and this kind of structure dissipates heat during the process which requires proper ventilation to cool down batteries as well as the instrument panel. In addition, all batteries dissipate hydrogen and oxygen gases during charging, and a rate of hydrogen dissipation must be maintained below 2% as it badly damages the system if the value of hydrogen goes beyond 2% [11]. Also, the system housing box must resist the water and dust during the heavy rain, storm as well as in the dusty environment, and therefore, it should be sufficiently weatherproofed, and dust proofed. The LCC previous design of housing box was very bulky as shown in the Fig. 6 below as well as it was unable to resist the moisture during the heavy rain; therefore, it needed to be redesign according to the Ingress Protection Code (IP Code).

Fig. 6. LCC old control housing box [12].

Before designing a new control housing design, I had to define a suitable IP code for the new system. *AS60529-2004 Degrees of protection provided by enclosures (IP Code)* is the standard for defining IP codes for any system. According to the standard, IP code contains two numerical codes, where the first numeral defines the solid particles and dust, and the second numeral describes the waterproofing or water resistance. The characteristics of each numeral of the IP code is as described as Fig. 7 below.

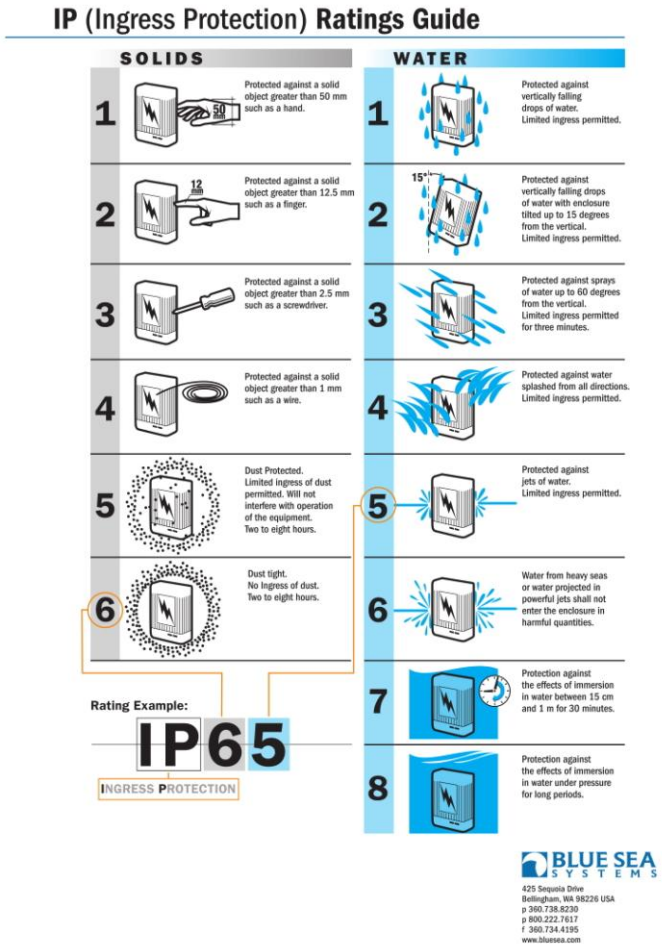

Fig. 7. IP chart rating for protection of control housing [13].

The working conditions of the control housing require to cope with high wind, rain and hailstorm sometimes, and therefore the design of housing box should be such a way that it can resist water and dust particles and at the same time, it should provide proper ventilation for electronic components inside the box. From IP chart, the most suitable IP code for FRSWS is IP 53 which can protect from dust as well as up to 60 degrees inclined rain. The design of housing box required to be made by considering IP 53 code, and thus the housing box with a sliding door rather than a hinged door as described in Fig. 6 which would be more appropriate to provide a seal against water and dust. The final design of the housing box is as below in Fig. 8.

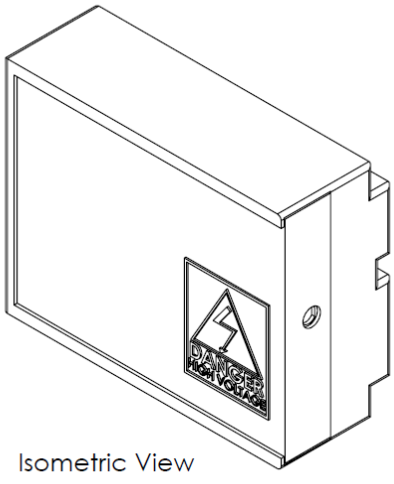

Fig. 8. IP chart rating for protection of control housing

VI. TRENCHING AND CABLE DESIGN STANDARDS

Trenching is a process of excavating the surface of the ground to install the system cables [10]. The cost of a trench in urban areas could be around $250 per meter and it carries 70% of the overall cost of the project. Trenching and wire design are an important part of FRSWS because the system is having many electronic components, which should be buried securely in order to keep the operating condition safe. The main underground wirings and trenching standards are described in *AS/NZS 3000:2007 wiring rules* where all kinds of wiring, enclosures, underground wirings have been described. The degree of protection provided by the enclosure has been described in the *AS 60529 Degrees of protection provided by enclosures (IP Code)* section.

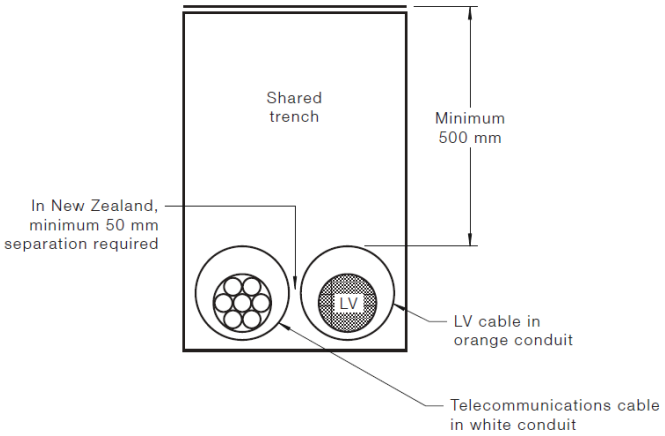

Fig. 9. The required depth of the trench for underground wiring of cable for system housing.

In the FRSWS, the arrangement of the communication cable from the float switch would be underground, so the minimum depth can be 450 mm to 500 mm for communication line wirings and low voltage wires as shown in Fig. 9. On the other hand, in case of High voltage wires, the minimum depth of trench should be 750 mm with covering or shielding the wires.

VII. CONCLUSION

The Flooded Road Smart Warning Project would be extremely effective when it comes to saving peoples' lives during the heavy rain and flash flood, however, the design of the sign should follow the proper standards and at a proper positioning on the site. The LED warning lights or flashing light should be having around 700cd luminous intensity so people can easily notice the sign from a fair distance on the road. The positioning of the sign, on the other hand, should include a warning sign W5 as well as G9-21-1 and for a 60km/hr zone, the smart sign should be 100-110m from the flood zone. Also, the system housing box would be made by considering IP 53, which can protect the box and electronic components inside from dust and rain but allow some air for ventilation for batteries as well as electronic parts. For environmental sustainability, 3-D printed system housing box from e-waste would be used in this project; moreover, solar panels could be employed to recharge the batteries.

REFERENCES

[1] Ga.gov.au. (2018). *Basics | Geoscience Australia*. [online] Available at: http://www.ga.gov.au/scientific-topics/hazards/flood/basics [Accessed 20 Nov. 2018].
[2] Ladds M, Keating A, Handmer J and Magee L (2017) How much do disasters cost? A comparison of disaster cost estimates in Australia. *International J of DRR*. 10.1016/j.ijdrr.2017.01.004.
[3] K. Haynes, L.C.F.O.A.G.D.B.R.H.D.R.R.D.C.S., 2016. *AN ANALYSIS OF HUMAN FATALITIES FROM FLOODS IN AUSTRALIA 1900-2015*, Sydney: Bushfire and Natural Hazards CRC.
[4] Anon., (2015). World Disasters Report, Geneva, Switzerland: International Federation of Red Cross and Red Crescent Societies.
[5] Goswami, G., (2017). Flooded Road Smart Warning System Project (pp. 1-2), Griffith University, Brisbane: Logan City Council FRSWS.
[6] Manual Uniform Traffic Control Device (MUTCD) *(Department of Transport and Main Roads)*, (2003), Part-1 *'General Introduction and Sign Illustrations'*. pp. 1-6.
[7] Manual Uniform Traffic Control Device (MUTCD) *(Department of Transport and Main Roads)*, (2009), Part-2 *'Traffic Control Devises For General Use'*.

[8] Logan Flooded Roads Smart Warning System. (2018). 1st ed. [ebook] Brisbane: Institute of Public Works EngineeringAustralasia,Queensland.,pp.14-15.Available at:http://ipweaq.intersearch.com.au/ipweaqjspui/bitstream/1/3545/1/Logan%20Smart%20Warning%20System.

[9] Manual Uniform Traffic Control Device (MUTCD) *(Department of Transport and Main Roads)*, (2009), Part-2 (pp. 180-186) *'Traffic Control Devises For General Use'*.

[10] Goswami, G., (2017). Flooded Road Smart Warning System Project (pp. 15-16), Griffith University, Brisbane: Logan City Council FRSWS.

[11] *Australian Standard 4086.2:1997 Secondary Batteries for Use with Stand-Alone Power Systems-Installation and Maintenance.*

[12] Lewis, H., 2016. *Industry Affiliates Program: Flooded Roads Warning project, Griffith University*, Gold Coast: s.n.

[13] Bluesea.com. (2018). *IP (Ingress Protection) Ratings - Blue Sea Systems*. [online] Available at: https://www.bluesea.com/resources/117 [Accessed 3 Dec. 2018].

[14] Anon, (2016). [online] Available at: https://www.acc.gov.au/system/files/optus%20Appendix %20c%20-%20Technology%20and%20network%20deployment.pdf [accessed 24 May. 2019].

