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MODIFIED DESIGNS FOR RIGID CONCRETE BARRIERS

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ABSTRACT

Among all types of traffic barriers in use fatal collisions are reported more with concrete barriers. They have excellent strength and stability in preventing the spillover of the accidents. But their rigidity and poor collision absorption capacity are causes for concern. Various studies are being conducted to improve these barriers. In this study two modified models of concrete barriers are proposed. Metal sections are added to the concrete members to enhance the collision absorbing capacity. Though they are expensive compared the concrete barriers they can be helpful in saving lives.

Keywords: Collision, concrete barriers, metal sections, fatal, RCC frame

INTRODUCTION

Crash barriers serve various functions depending on their location. Median barriers function is to prevent collisions with vehicles coming in the opposite direction, Road side barriers need to control the traffic from making accidents with out of carriage way or road side hazards and bridge side barriers arrest the users from falling over the bridge. These barriers are made up of various materials like reinforced concrete, steel beams and channel sections and cables or wire rope etc. Concrete barriers are more durable, easy to maintain and bulky. They are strong, stable and rigid and good at decelerating the colliding vehicles including heavy trucks. Concrete barriers can be constructed either as pre cast barriers or cast in situ barriers They are widely used across the world since a long time particularly as median barriers and bridge side barriers. However their collision energy absorbing capacity is less and hence causes severe damage to the vehicles and passengers during collisions. Many fatal accidents involving collisions with traffic barriers are reported . Collisions with traffic barriers accounts to 9% [1] of fixed object crash deaths in USA in 2017 as shown in figure 1. In this study an attempt has been made to improve the collision absorbing capacity of the concrete barriers without affecting their strength and stability.

LITERATURE REVIEW

A tata indica car collided with a divider as shown in figure 2 leading to the death of 3 youth in Jalandhar India[2] in November 2018. Former union minister and newly elected law maker in the state of Karnataka in

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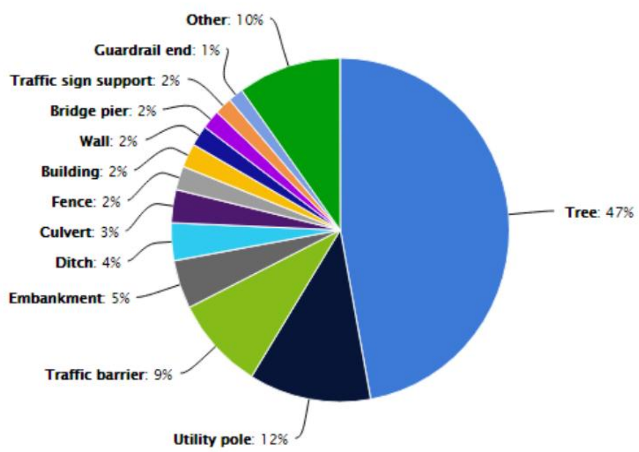

Figure 1. Types of fixed object crash deaths in America 2017

Figure 2. Car hitting a rigid divider

India died when his car hit a divider in May 2018 [3] . Two young students riding a motor cycle collided with a median and crashed into a tree and died in Bangalore in November 2016 [4]. Telugu actor and his friend were killed when their over speeding car rammed into a bridge side barrier near Tumkur in December 2012 [5]. All these fatal accidents are reported from a single state of Karnataka, India. Though such collisions may be decreasing in numbers several such unwanted incidents are yet happening across the world. Whatever may be the reason for the collision, the characteristics of the barriers play a formidable role in the severity of the damage. Though strong concrete barriers can with stand the impact of heavy trucks [6] as shown in figure 3, their high stiffness can be the cause of fatal collisions with high speed cars and motor cycles as shown in figure 2. Several researchers are identified the need to find alternatives and modifications to rigid barriers . A hybrid barrier consisting of wood and sand as the main materials that has enhanced energy absorption capabilities was proposed [7] . A proposal was made to study the advantages and disadvantages of introducing rolling barriers on Mumbai-Pune expressway India [8].

Figure 3. A truck tipped over a concrete divider

Figure 4. A typical concrete divider

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MATERIALS AND METHODS

In this study commonly used rigid concrete barrier shown in figure 4 is modified to provide some flexibility by attaching metal sections to the concrete barriers. These metal sections can break the collision momentum and enhance the impact energy absorbing capacity of the concrete barriers. The materials proposed in these systems are the commercially available and tested materials. M40 Grade of concrete as per IS 10262:2009 and steel reinforcement of 12 mm size main bars and 6 mm size stirrups can be used in concrete barriers. Height of the popular dividers can be retained for these modified barriers also. W steel beams having depth 312 mm and thickness 3 mm and steel channel sections of size 150x75x5 mm [9] as shown in figure 5 are used. Both these products are cold roll formed and hot dipped galvanized conforming to IS 5986 Grade Fe 360/Fe 410, IS 10748 Grade II or equivalent [10] . These sections are popularly used in semi rigid metal crash barriers in the highway sector. As all the materials are commercially available and tested products and the as the basic shape and height of the models is in conformance with the standard concrete dividers, further testing of systems is not under taken. Models strength and stability can also be verified using any standard structural analysis software.

RESULTS AND DISCUSSION

Main focus of this study is to increase the impact energy absorption capacity of the rigid concrete barrier. Two modified models of RCC barriers are proposed. In both the models the thickness of concrete section is reduced in the middle. Modified section appears like a RCC frame consisting of top beam, wall panel of reduced thickness in the middle, vertical supporting posts at intervals of 3m and a concrete footing at the bottom as shown in figure 6. Top beam of size 300x150 mm and vertical posts of size 300 mm x 200 are considered. The middle wall portion thickness is considered as 200 mm. In model 1, as shown in figure 7 , W metal beams are run longitudinally along the barrier at the height of collision. They are supported on the vertical posts. In model 2 instead of W beams vertical channel sections are attached to middle wall portion as shown in figure 8. They are fixed at a spacing of 200 mm c/c. W beams in model 1 and channel sections

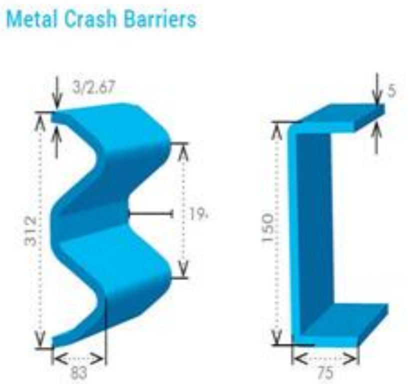

Figure 5. W metal beam and channel sections

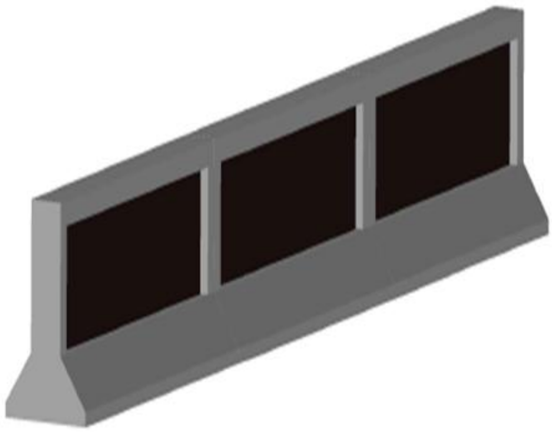

Figure 6. Concrete barrier with reduced middle thickness

in model 2 are provide d on both sides of the barrier. End vertical concrete posts in model 1 and all the concrete posts in model 2 are covered with horizontal channel sections to protect from the collisions to the posts. Various metal sections attached to the rigid concrete barrier can enhance the collision absorbing capacity and minimize the fatal damage to the vehicle passengers. Addition of these metal sections can increase the initial as well as maintenance costs of the barriers. But as the main purpose of the dividers is protect the road users, the increase in the cost need not be a cause for their rejection. These modifications are suitable for all concrete barriers and particularly highly recommended wherever there is a possibility of high speed cars and motor cycles likely to hit the concrete barriers like in the city roads.

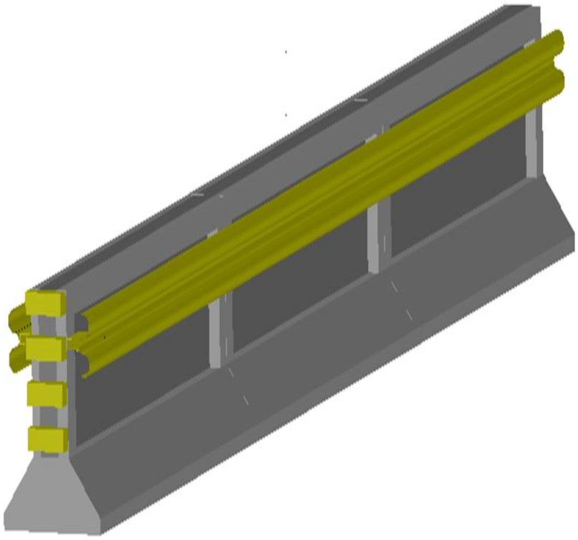

Figure 7. Modified RCC barrier Model 1.

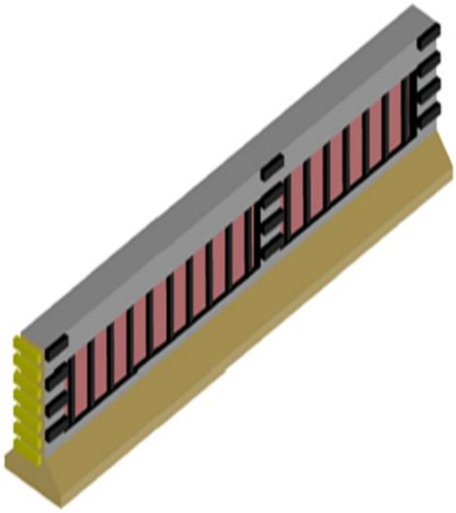

Figure 8. Modified RCC barrier Model 2.

CONCLUSION

As rigid concrete barriers are playing lethal during collisions two modified models are proposed to enhance their collision absorbing capacity. In these models continuous concrete frame is converted to a concrete frame. Middle portion thickness is reduced and is supported by bottom foundation, vertical posts and top beam. This frame is fixed with W metal beams in longitudinal direction in model 1 and vertical channel sections in model 2. Vertical posts are also covered with metal sections to minimize the collision damage in case the vehicles hit the posts. The initial and maintenance costs can be high due to the addition of metal sections. But can be implemented to protect the lives of passengers.

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