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Experimental application of EPS concrete in the new prototype design of the concrete barrier

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HIGHLIGHTS

- A new concrete barrier (NCB) is fabricated with a new shape.
- EPS concrete is applicable in the concrete barrier.
- The new model absorbs more impact energy using EPS beads.
- EPS concrete energy dissipation is higher than that of normal concrete.
- NCB undergoes failure only at the part facing the strike load.

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ABSTRACT

A new concrete barrier (NCB) design that separates the opposing lanes in roads was presented and tested experimentally. The proposed design comprises three parts. The expanded polystyrene (EPS) beads were used to cast the outer parts with 15%, 30%, and 45% replacement from coarse aggregate by volume with silica fume substituted with 10% of cement. Four pressures were applied to the concrete barrier models (2.3, 3.2, 4.5, and 5.8 MPa), which are respectively equivalent to four operational speeds of the vehicles (50, 70, 100, and 130 km/h). Results showed that the failure occurred only in the outer part facing the strike force, and the other parts did not fail. The use of EPS beads with percentages of 15% and 30% was to absorb the impact loads in a good way, and these percentages are better than 45%. The results demonstrated little lateral deflection. Moreover, the EPS beads led little strains and facilitated to absorb the impact force. The new prototype of concrete barrier can be functional in roads with good energy dissipation, and it has conformed with the requirements of the crash concrete barrier test.

1. Introduction

Concrete road barriers are used to divide opposing lanes of all types of highway roads. Concrete barriers are important in preventing vehicles from entering the opposite lane. Serious traffic accidents may occur when a vehicle crosses to the opposite lane; therefore, concrete barriers are necessary to prohibit vehicles from crossing to the opposite lane and to protect drivers from injury or death and prevent vehicle damage. In addition, concrete barriers are used to prevent vehicles from entering dangerous areas, such as roadsides, narrow medians, and bridge barriers [1,2].

The protection of road users is one of the most important highway transportation problems. Road accidents may cause death because of currently inadequate concrete barriers. Reducing the effect of vehicle collisions with concrete divider barriers can enhance road safety. Newly designed concrete barriers can absorb large amounts of the energy released in collisions and minimize damage to both vehicles and the concrete barriers.

When a vehicle collides with a concrete barrier, the minimization of the continuity of the collision is very necessary. Existing concrete barriers are too solid. Concrete composite materials that are more flexible and elastic than normal reinforced concrete can absorb vehicle impact as well. Several types of concrete barriers vary in shape, height, width, length, and connection design. In

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addition, many forms of anchor methods have been improved to reduce the lateral deflection of concrete barrier systems [3].

In some cases, improving road protection is necessary to prevent pedestrians and vehicles from traveling to unsafe districts or using destructive methods. Concrete barriers should be designed such that they can absorb as much of the impact load as possible, which is exerted by vehicles that collide with them, and simultaneously preserve their stability [4].

In the last few years, practical observations have shown that the installed systems along Malaysian highways have remained unchanged. Concrete barriers must be easy to install. Moreover, the concrete barrier design permits replacement, exclusion of sections for repair, and emergency openings. In view of these benefits, the use of concrete barriers in high-impact areas has risen in recent years. More importantly, highway roads require concrete barriers [5,6].

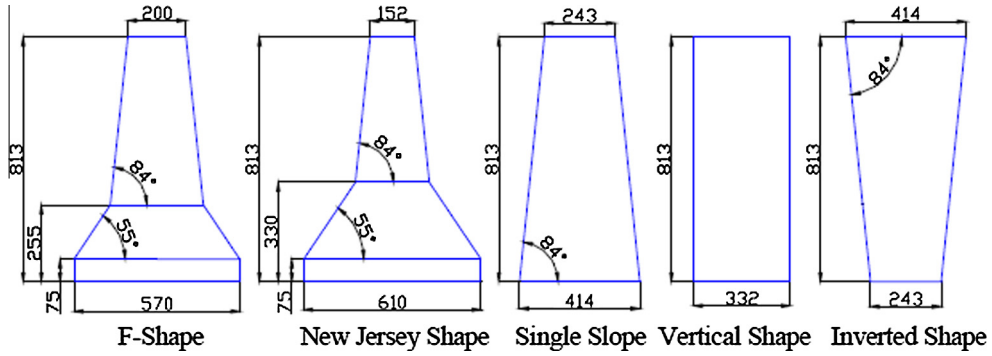

Fig. 1. Types of concrete barrier shapes [5].

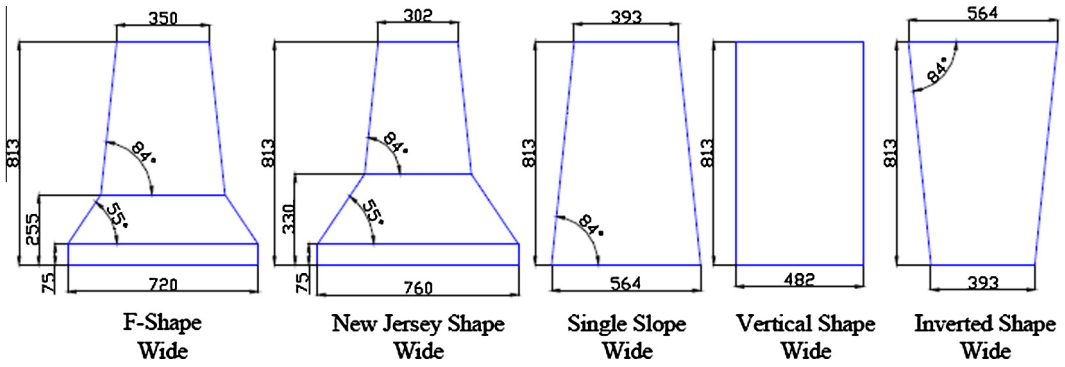

Fig. 2. Wide safety shapes [5].

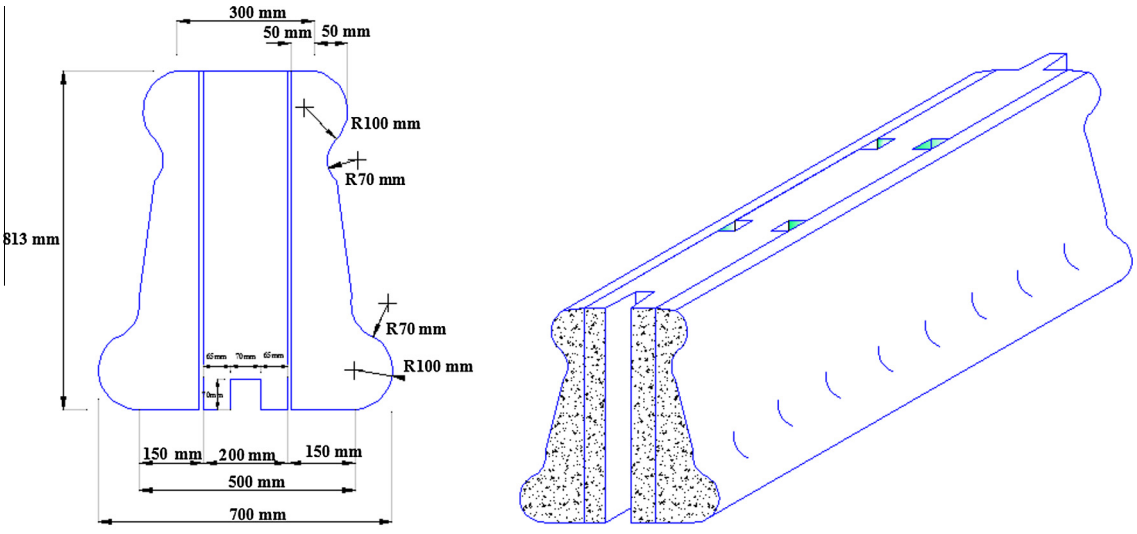

Fig. 3. New prototype of concrete barrier shape.