**Volvo XC90 Testing by Thatcham Research**

**Tempe, AZ**

**HWY18MH010**

(10 pages)

# ADAS 18-15 XC90

Thatcham Euro NCAP EPT/EBT Report

SEPTEMBER 1, 2019

# INTRODUCTION

## Background

Car to pedestrian and car to cyclist collisions account for 20% and 10% of killed and seriously injured on UK roads respectively.

The most common car to pedestrian collision scenario is the pedestrian stepping into the road and walking into the path of a vehicle travelling at typical urban speeds. These types of collisions often leave the driver with very little time to react and pedestrians can sustain severe head, chest and leg injuries.

To support the driver vehicle manufactures offer active safety technology that continuously monitors for collision threats and can automatically intervene to maintain safety. One such technology, called Autonomous Emergency Braking (AEB), can detect critical situations developing and automatically apply emergency braking to mitigate or even avoid a collision altogether. At higher speeds warnings sound to alert the driver so they can take appropriate action. Systems that are sensitive to and react in imminent collisions with vulnerable road users such as pedestrians and cyclists are called AEB VRU systems.

Since 2016, Euro NCAP have assessed 41 vehicle models from 18 manufacturers fitted with an AEB VRU system fitted as standard equipment. In 2018 Euro NCAP increased the scope of the VRU AEB assessment to include night time pedestrian scenarios, pedestrian walking parallel to the test vehicle scenarios and cyclist detection scenarios.

The Volvo XC90 was tested by Euro NCAP in 2015 before AEB VRU systems were assessed as part of the rating scheme. However the vehicle is equipped as with a car, pedestrian and bicyclist sensitive Autonomous Emergency Braking (AEB) system which has the potential to mitigate or even avoid collisions in some cases. The Volvo City Safety system was assessed by Euro NCAP in 2017 when fitted to a Volvo S90 and scored highly, including points for being operational in low ambient light conditions.

After a fatal collision involving a pedestrian wheeling their bicycle across the path of an Uber Volvo XC90 travelling along a highway at night in the US in March 2018, Thatcham Research tested a Volvo XC90 in a representative scenario under similar conditions to assess the performance of the AEB system. Details known about the accident at the time of Thatcham’s testing are; the pedestrian walked across several lanes of traffic before entering the path of the vehicle from the left, the vehicle was travelling at 38mph (61km/h), the vehicle did not brake in response to the pedestrian and the pedestrian had crossed ¾ of the width of the vehicle at the point of impact.

**Figure 1: Dashcam footage showing the moments before the accident**

**Figure 2: An image of the vehicle involved shows the impact position**

## Aim, objectives and method

To assess the performance of the Volvo XC90 City Safety collision avoidance system when a pedestrian, pushing a bicycle, crosses the road into the path of the vehicle during darkness with limited street lighting.

The testing performed was based on the Euro NCAP car to pedestrian crossing scenario, albeit modified with the adult walking dummy pushing a bicycle and approaching from a range equivalent to crossing three lanes of a highway before entering the lane in which the test vehicle was travelling. The pedestrian walking speed was 5km/h and the test synchronised such that when maintaining constant test vehicle speed (i.e. no pre-impact braking intervention), the pedestrian walked into the path of the vehicle and the impact position was three quarters of the way across the width of the vehicle. The testing was completed in darkness (<1lux) with the test vehicle headlights set to automatically adapting high beam. Otherwise the testing was performed using Euro NCAP specification test equipment according to the methodology described in the test protocol.

## Results Overview

At test vehicle speeds of 30, 40, and 50km/h the Volvo XC90 City Safety system was able to identify the imminent collision and react by automatically applying emergency braking sufficient to stop the vehicle before it crossed the pedestrian path, thus avoiding a collision with the pedestrian.

At a test speed of 60km/h the system was able to identify the imminent collision and react by automatically applying emergency braking which reduced the speed to 37km/h at the point of impact with the pedestrian.

The City Safety system also provides a visual and acoustic Forward Collision Warning (FCW) to the driver inside the vehicle and offers braking support which boosts the driver applied braking when a potential collision is identified. In this case it was found that an alert driver, reacting by braking heavily in response to the collision warning, could mitigate the impact speed from 60km/h to approximately 15km/h. It was also possible for the driver to respond to the collision warning by swerving to pass behind the pedestrian, however this required relatively harsh steering.

# METHOD

- **Equipment Setup**

The testing was completed on the 22nd March at the Thatcham Research Upper Heyford test facility on a clean, dry road surface. It was conducted between 2000 and 2330 during the hours of darkness on an overcast night with ambient lighting measured at consistently less than one lux.

For accuracy and repeatability purposes the test vehicle was equipped with an ABD driving robot system, consisting of an SR60 Torus steering robot and a CBAR 500 combined brake/accelerator robot. An OXTS RT3002 GPS corrected inertial motion pack was used for the measurement of vehicle dynamics and position. The equipment is set up to control the speed and path of the test vehicle in accordance with the Euro NCAP test protocol without impeding the actions of the collision avoidance technology on the vehicle.

The pedestrian target used for this testing was a 4activeSystems Euro NCAP Pedestrian Target adult ($EPT_a$), dressed in a black shirt and blue trousers, positioned alongside a Euro NCAP bicycle target (EBT) as though the pedestrian was wheeling the bicycle along. The EPT and EBT are designed to replicate the visual, radar and lidar attributes of a typical pedestrian and bicycle respectively and are repeatedly impactable without causing significant damage to the test vehicle. The EPT and EBT were mounted on a 4activeSystems surfboard platform, propelled by an ABD Soft Pedestrian System.

- **Scenario Setup**

The test vehicle was driven along a straight path (lateral deviation less than ±0.1m), at a constant test speed (tolerance ±0.5km/h) towards the projected impact position with the pedestrian dummy. The vehicle was tested at speeds ranging from 30km/h up to 60km/h. The testing was completed with the vehicle headlights set to automatically adapting high beam.

The EPT and EBT combination was propelled at a constant speed of 5km/h along a path perpendicular to that of the test vehicle. The path length was representative of crossing thee lanes of a highway before entering the lane in which the test vehicle was travelling. The test equipment was synchronised such that when maintaining constant test vehicle speed (i.e. no pre-impact braking intervention), the EPT and EBT combination walked into the path of the test vehicle and the EPT impact position was three quarters (75%) of the way across the width of the test vehicle.


**Figure 3: Test vehicle (top), ABD Driving robot install (bottom left), 4a EBT and EPT combination (bottom right)**

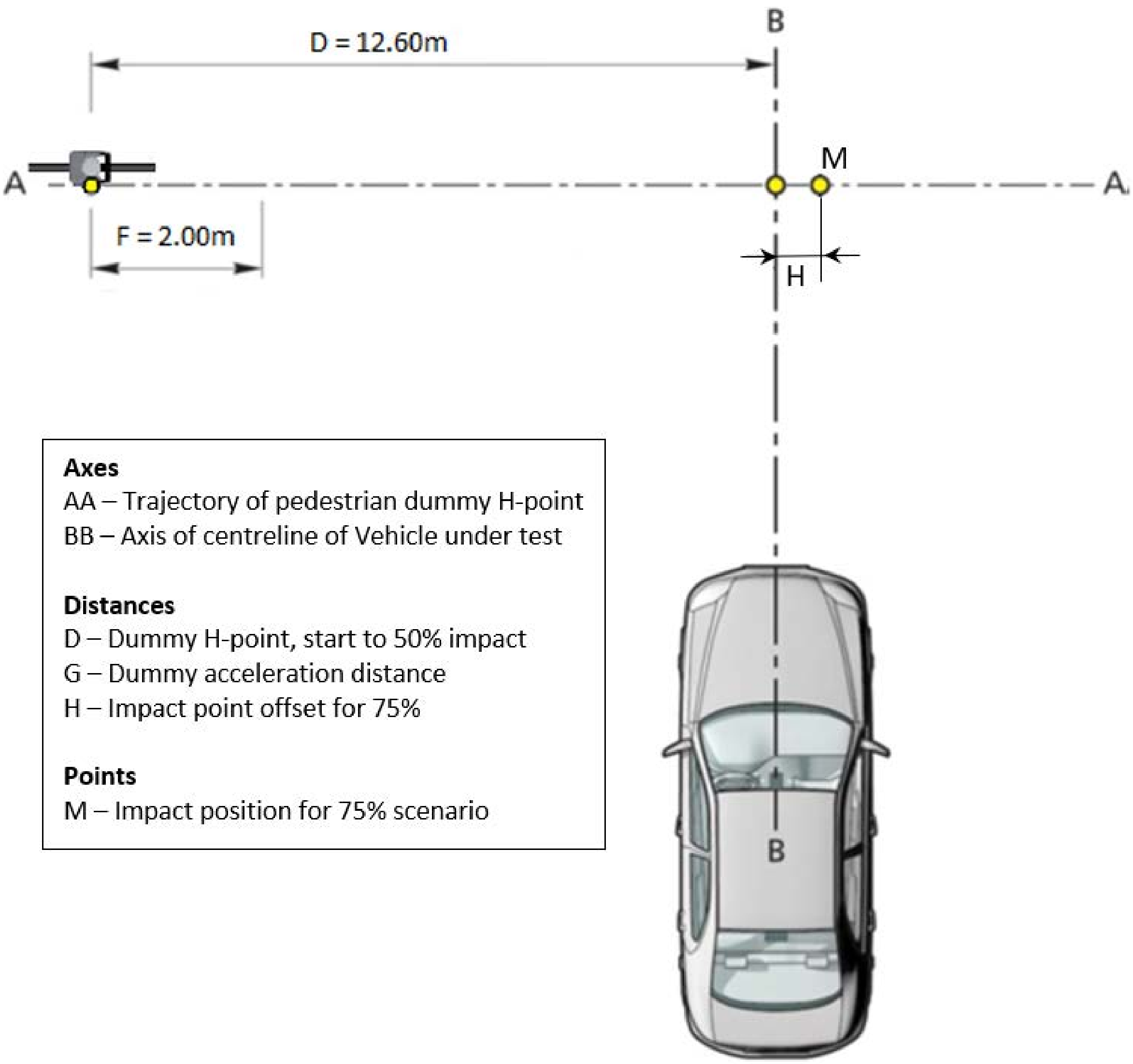


**Figure 4: Test scenario schematic (showing cyclist, not pedestrian wheeling bicycle)**

## RESULTS

| Test speed (km/h) | Result | Impact speed (km/h) | Avoidance distance (m) |
|---|---|---|---|
| 30 | Collision avoided | - | 1.06 |
| 40 | Collision avoided | - | 0.46 |
| 50 | Collision avoided | - | 0.54 |
| 60 | Collision mitigated | 37.3 | - |
| 60 * | Collision mitigated | ~15 | - |

* In this test the driver applied the brakes manually in response to the forward collision warning. In all other test runs the braking was automatically applied by the test vehicle in response to the imminent collision.

## CONCLUSIONS

The aim of this exercise was to evaluate the performance of the Volvo City Safety system fitted as standard to production specification Volvo XC90 vehicles in a night time pedestrian scenario. The City Safety system had previously been assessed by Euro NCAP when fitted to different vehicle models and scored highly, including scoring points for being operational in low ambient light conditions.

The scenario in which the vehicle was assessed was designed to be representative of a fatal collision that occurred in March 2018, as detailed in the introduction. The test was performed using equipment and methodology used for Euro NCAP testing, albeit with a target modified to combine a pedestrian and bicycle.

In the assessment the City Safety system fitted to the Volvo XC90 was able to recognise the target in low light conditions and automatically apply the brakes to avoid a collision at test speeds up to and including 50km/h. At 60km/h (the vehicle speed in the fatal accident) the City Safety system was able to recognise the target, emit a forward collision warning to alert the driver before automatically applying the brakes to reduce the speed of the impact to 37km/h (23mph).

The results of this assessment indicate that if the vehicle involved in the original accident had an operational, production specification City Safety system active at the time of the collision the system would have detected the pedestrian and bicycle as a collision threat, emitted a forward collision warning and, had the driver not responded, automatically applied the brakes to reduce the impact speed.