

Euro NCAP MPDB Compatibility Assessment

Occupant Load Criterion calculation

Introduction

This document describes the Occupant Load Criterion (OLC) calculation performed in the REPORTER templates:

- Euro NCAP MPDB Compatibility Assessment **2020**
- Euro NCAP MPDB Compatibility Assessment **2023**

The calculation follows the method specified in the Euro NCAP [Technical Bulletin \(TB 027\) v1.1.1](#), which is intended to be used with the Adult Occupant Protection [Assessment Protocol v9.1.1](#).

The OLC calculation itself is contained within the script:

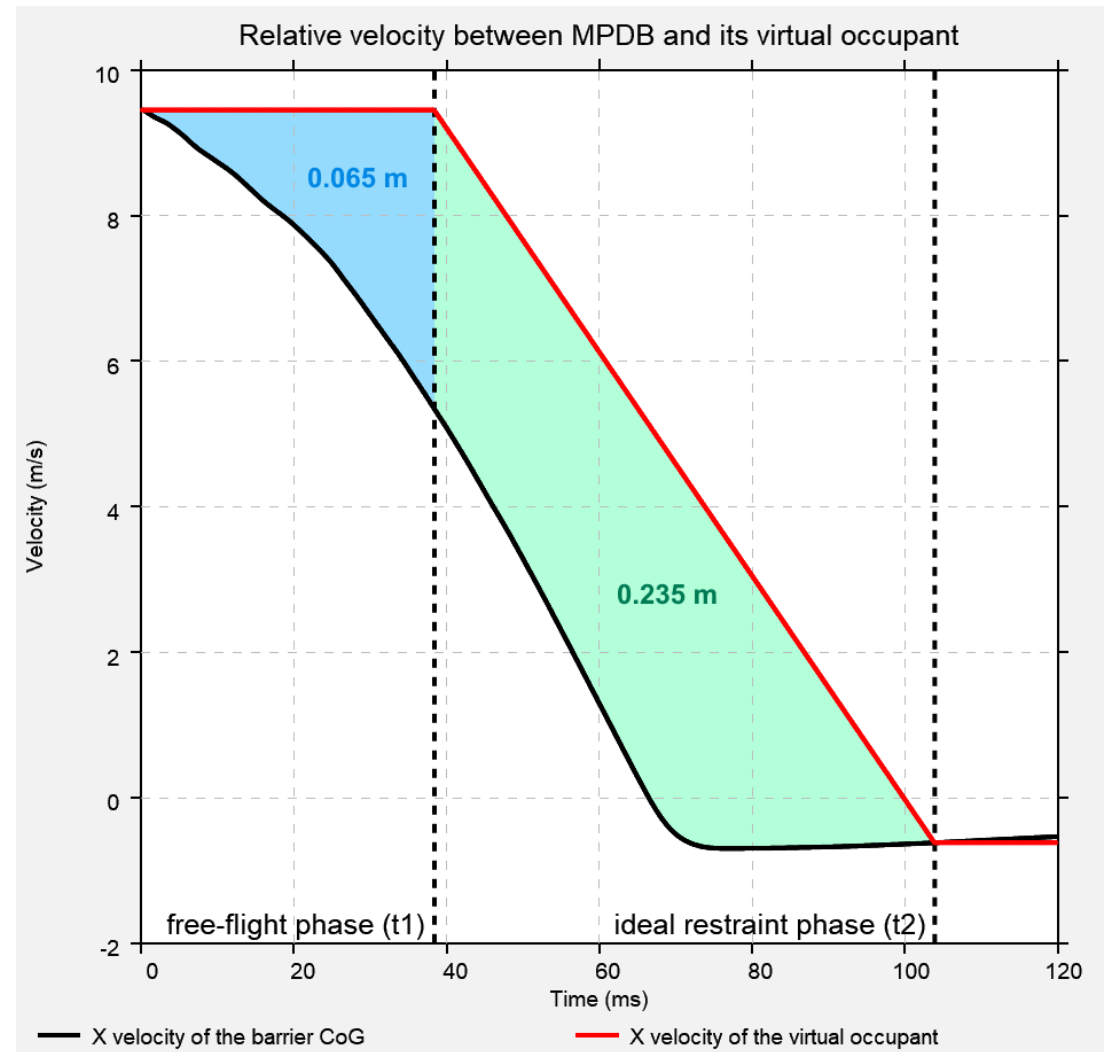
```
%TEMPLATE_DIR%/scripts/MPDB/this_MPDB_Impact_common.js
```

Occupant Load Criterion (OLC) calculation

According to TB 027, the virtual occupant velocity is piecewise linear: a **free-flight phase** in uniform motion (zero acceleration) is followed by an **ideal restraint phase** with constant deceleration (in g units) equal to the OLC:

- [3.5.2]
- t_1 is end of the free-flight-phase of a virtual dummy on the barrier along a displacement of 0.065m, and
 - t_2 is end of the restraining-phase of a virtual dummy on the barrier along a displacement of 0.235m after the free-flight-phase (i.e. in total 0.300m displacement for the virtual dummy).

The **blue** and **green** shaded areas show the relative displacement between that barrier and its occupant during the two phases.



Calculating end of free-flight phase (t_1)

The T/HIS JavaScript¹ reads and filters the barrier's x-velocity and records the initial velocity V_0 , and integrates to find the x-displacement $s_{MPDB}(t)$. The displacement $s_{FF}(t)$ of the virtual occupant in its free-flight phase is therefore:

$$s_{FF}(t) = V_0 t$$

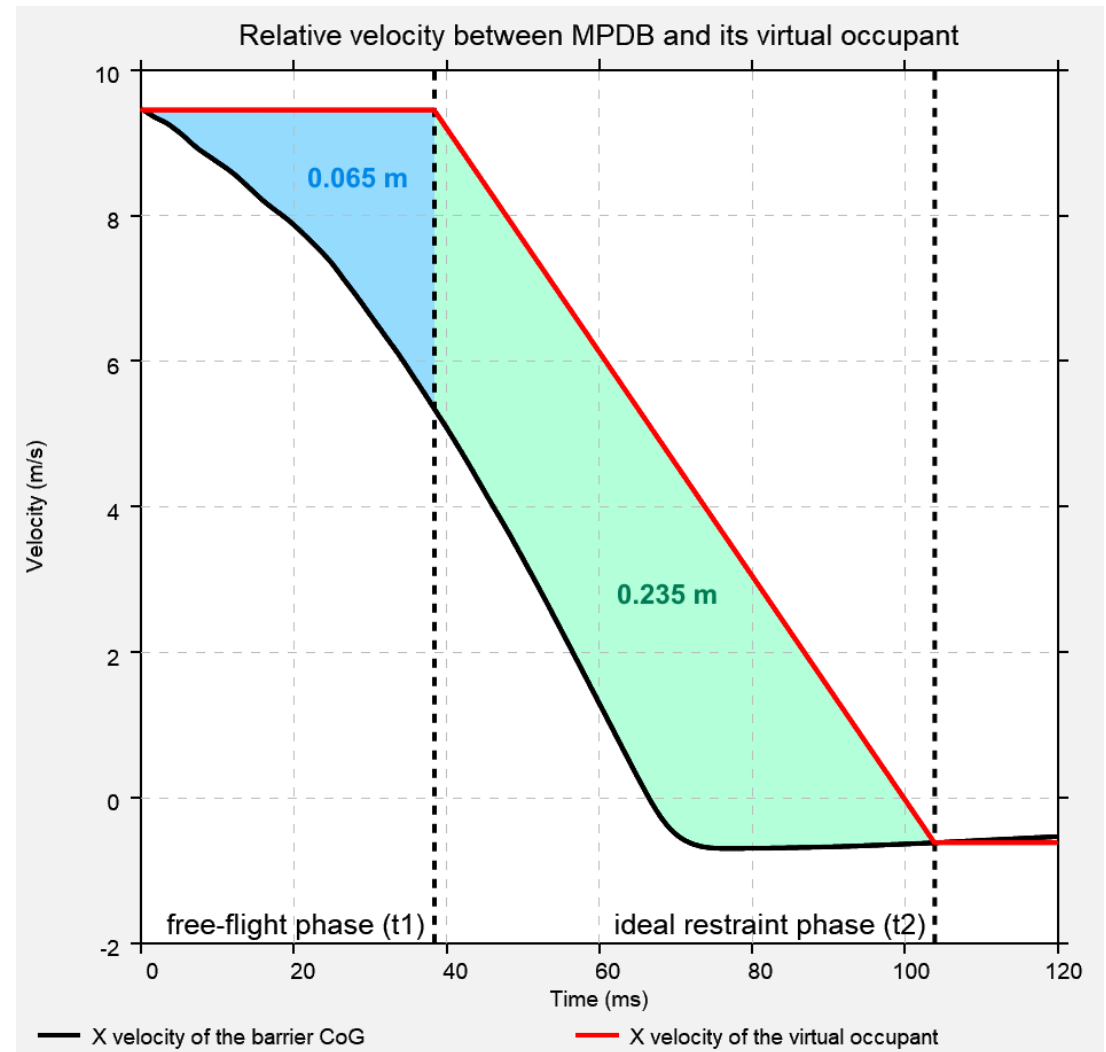
The relative displacement Δs between the virtual occupant and the barrier is:

$$\Delta s = s_{FF}(t) - s_{MPDB}(t)$$

The script constructs a curve (called `free_flight_time`) of time t against Δs in order to determine t_1 (the time at which $\Delta s = 0.065 \text{ m}$).

¹ The OLC calculation is performed in the script:

%TEMPLATE_DIR%/scripts/EuroNCAP/**this_EuroNCAP_MPDB_Impact_common.js**



Calculating end of ideal restraint phase (t_2)

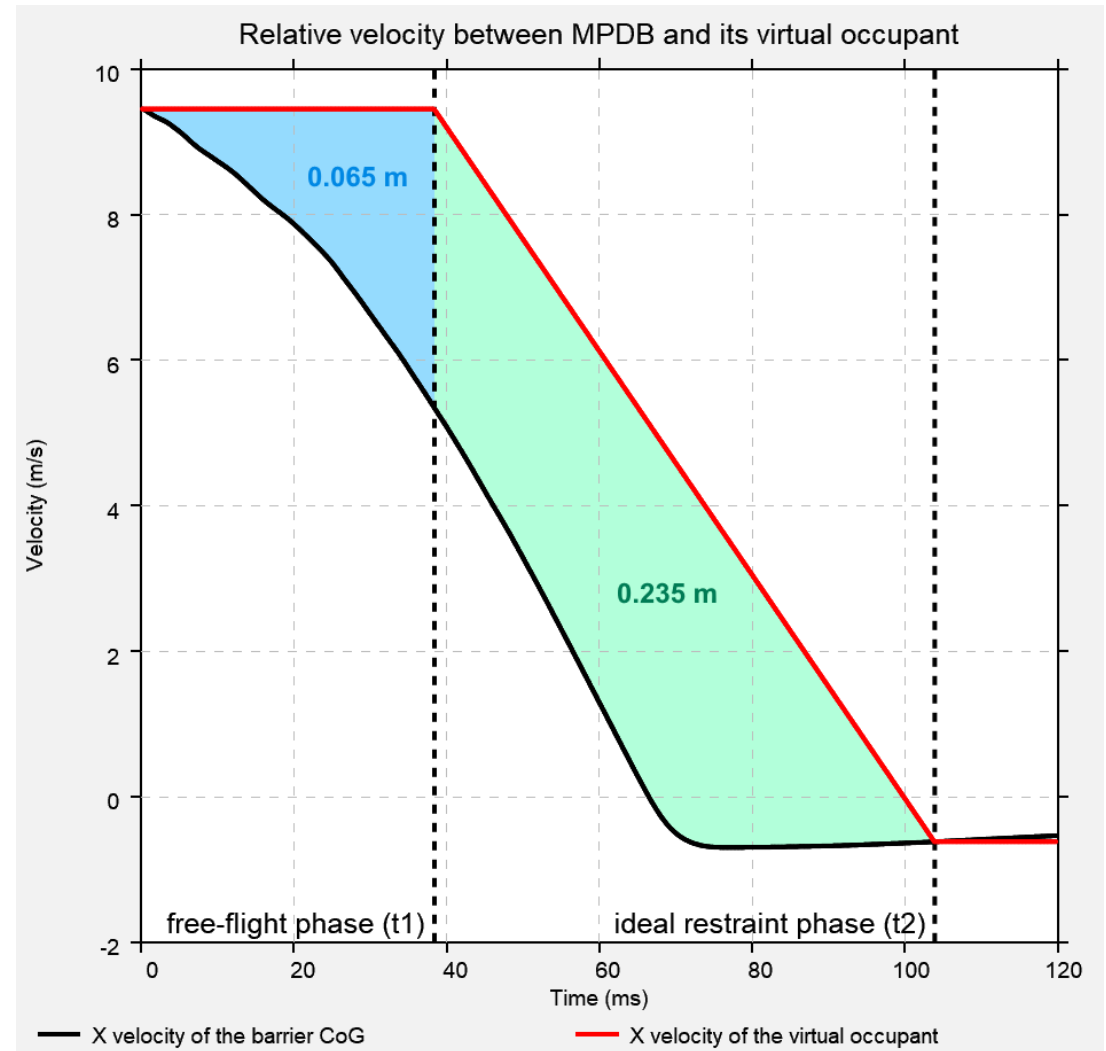
The end time t_2 of the ideal restraint phase is determined by iteration. For each iteration of t_2 , the relative displacement $\Delta S = s_{IR} - s_{MPDB}$ between barrier and virtual occupant is checked by subtracting the area under the barrier velocity curve (**black**) from the area under the virtual occupant velocity curve (**red**) to give the area highlighted in **green**.

The area under the barrier velocity curve is its displacement between times t_1 and t_2 :

$$s_{MPDB} = s_{MPDB,t2} - s_{MPDB,t1}$$

The area under virtual occupant curve (its displacement s_{IR} during the ideal restraint phase) is found by computing the area of the trapezium defined by t_1 , t_2 , the barrier's initial velocity $V_0 = V_1$ and the barrier velocity V_2 at t_2 :

$$s_{IR} = \frac{(V_1 + V_2)(t_2 - t_1)}{2}$$



Converging on a solution for the OLC

In the script, the following steps are performed iteratively until a converged solution is reached:

1. Assume an initial t_2 (on the first iteration it is assumed that $OLC = 0$ i.e. a lower bound to t_2 is assumed)
2. Lookup the barrier velocity V_2 at time t_2
3. Compute the associated OLC:

$$OLC = \frac{1}{9.81} \left(\frac{V_2 - V_1}{t_2 - t_1} \right)$$

4. Compute the relative displacement $\Delta s = s_{IR} - s_{MPDB}$
5. Adjust t_2 based on the computed Δs . If $\Delta s > 0.235 \text{ m}$ then t_2 is decreased; otherwise it is increased:

$$t_{2,UPDATED} = t_2 \left(1 + R \left(\frac{0.235}{\Delta s} - 1 \right) \right)$$

where $R = 0.1$ was selected from empirical testing

6. Check for the following three convergence criteria. If any of these is not satisfied, the iteration process is terminated:
 - i. Assume that a solution for OLC has been reached if a convergence tolerance of 10^{-6} is reached:
$$|0.235 - \Delta s| \leq 10^{-6}$$
 - ii. If the end t_2 of the ideal restraint phase is increased beyond the analysis termination time, then the process is terminated with no solution (a warning is printed in the template and $OLC = 0$ is returned)
 - iii. If the total number of iterations exceeds 100 then the process is terminated with no solution (a warning is printed in the template and $OLC = 0$ is returned)

Contact Information



www.arup.com/dyna

For more information please contact us:

UK

The Arup Campus
Blythe Valley Park
Solihull
B90 8AE
United Kingdom

T: +44 121 213 3399
dyna.support@arup.com

China

Arup China
39/F-41/F Huaihai Plaza
1045 Huaihai Road (M)
Xuhui District, Shanghai
200031
China

T: +86 21 3118 8875
china.support@arup.com

India

Arup India
Ananth Info Park, HiTec City
Madhapur Phase-II
Hyderabad
500081, Telangana
India

T: +91 40 44369797 / 98
india.support@arup.com

USA West

Arup Americas
c/o 560 Mission Street Suite 700
San Francisco
CA 94105
United States

T: +1 415 940 0959
us.support@arup.com

or your local Oasys distributor