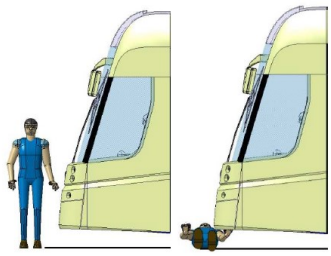
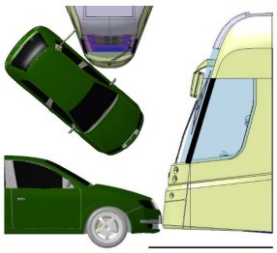
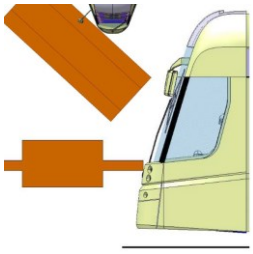
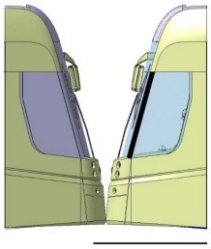
FRONT PART OF THE TRAMWAY VEHICLE – SAFETY VEHICLE FRONT (NOSE)

Attachments:

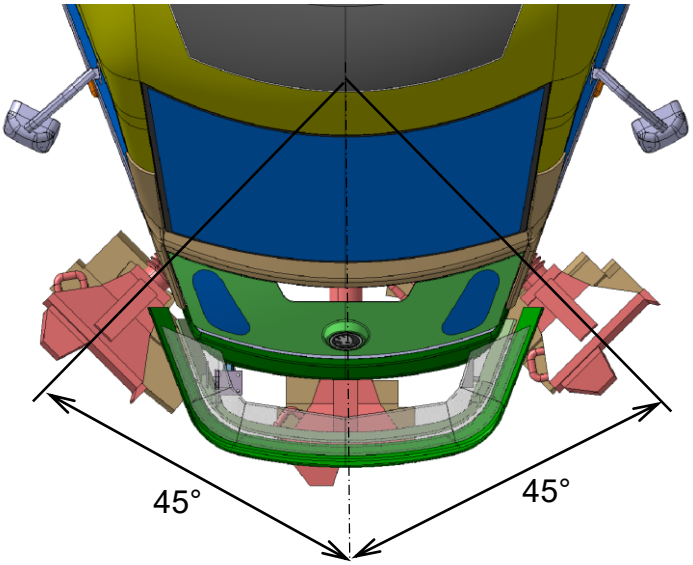
1. Type of collisions and general information

A pedestrian x tramcar	**B1 – B2** passenger car x tramcar	**C1 – C2** trucks or trailer x tramcar	**D** tramcar x tramcar
			
• Non-normalized collisions – legislation in preparation • Preferred smooth softened surface without any hard parts, positive front inclination and rounded shape, avoiding overrun • It is beneficial to take into account also collision with cyclists, dogs, etc.	• More details are presented in standard EN 15227 • Collision with 3t obstacle - represents collision with car • Collision speed 25 km/h • Obstacle can be moved only in tram driving direction	• More details are presented in standard EN 15227 • Collision with 7,5 t obstacle - represents collisions with light truck • Collision speed 15 km/h • Obstacle can rotate • (C3)Tanker truck have to be taken into account – legislation in preparation	• More details are presented in standard EN 15227 • Collision with same vehicle • Collision speed 15 km/h • Allowed construction static force 400 kN

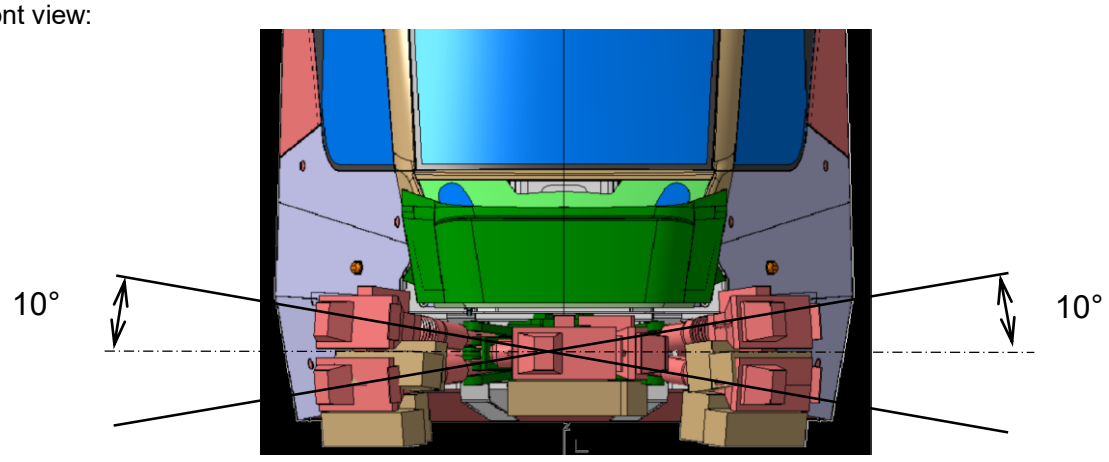
2. Coupling system – coupler

None of the proposed measures and none of the sub-systems shall limit the function of the coupling which is located (its axis) at height approximately 450-520 mm above top of the rail (TOR).

Top view:



Front view:



The functional area of the coupler is created by coupler dimensions and also by maximal operational angels in vertical plane (approximately 10°) and in horizontal plane (approximately 2x45°).

Unused coupler is folded and hidden behind the front of the vehicle

Space of coupling system can be passed in the form of 3D data.

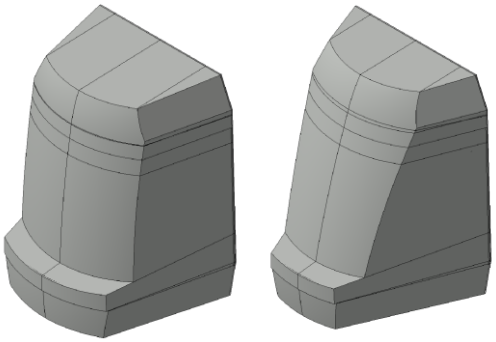
3. State of the art – some for inspiration for better problem understanding

Currently, there are two different approaches to solving FUP (front underrun protection) issues:

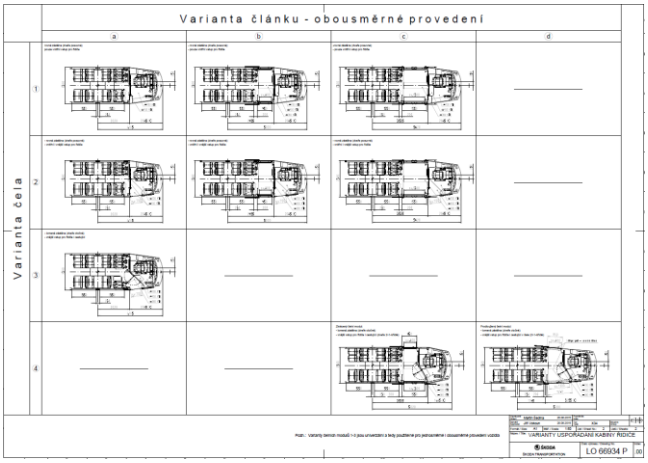
1) There is a tendency to merge the energy absorption function from tramcar vehicle (TV) and passenger car (PC) or the supply by reducing the position of the TV - TV bumper roughly to the FUP - PC level. The bumper enters the coupling function. In order to enable the coupling function, this approach leads to a "hinged" TV - TV bumper. In the case of two coupled vehicles, therefore, the bumper is inoperative, thus reducing the passive safety of the vehicle (sets of vehicles) in the event of a collision. Coupling dimensioning is always powerfully positioned under the TV - TV bumper design, and therefore this bumper benefits even when two vehicles are coupled.
2) The energy absorption from TV and PC or the supply is solved by separate systems. Here, the TV - TV bumper remains functional even when the vehicle is coupled because it is located above the coupling function area. In this case, however, it is necessary to raise the FUP-PC, which is, however, lighter and can be part of the lifted coupling housing. In this case, the bumper axis is approximately 820 mm above the TK.

4. Dimensions, shapes and configurations variability

The solution should also take into account the fact that tram vehicle have a wide range of possible face dimensions and shapes that can move within the limits below.
Limit face shapes can be passed in the form of 3D data.

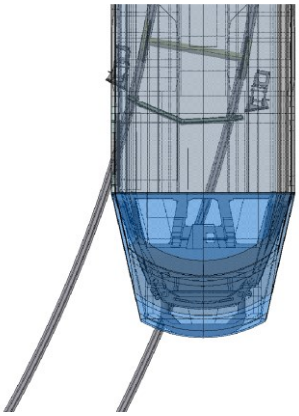


Vehicle front has also several configurations with different doors and without doors.
Some configuration examples are available in the form 2D data.



5. Other aspects and limitations

It is also useful to take into account the fact that the front of the tramway does not always have to move forward only in the direction of the longitudinal axis of the vehicle, but in the small radius arcs the "lateral movement" component is also significant. The FUPs underpass or some other system should also address this fact.

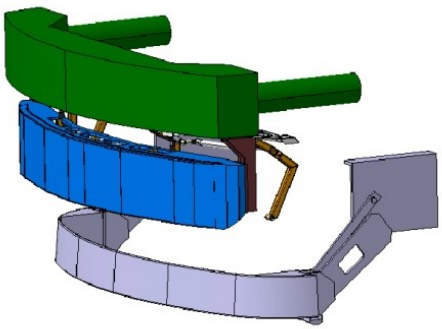


The tracks may also include rail tracks that may limit or complicate the reliable function of the proposed FUPs system. The proposed FUPs system should therefore also take into account types of track suits that are acceptable to the system.

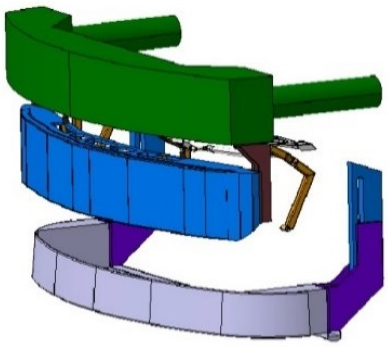


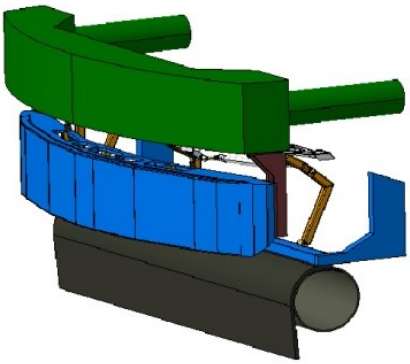
6. Examples of some ideas and solutions – bumper and FUP (front underrun protections)

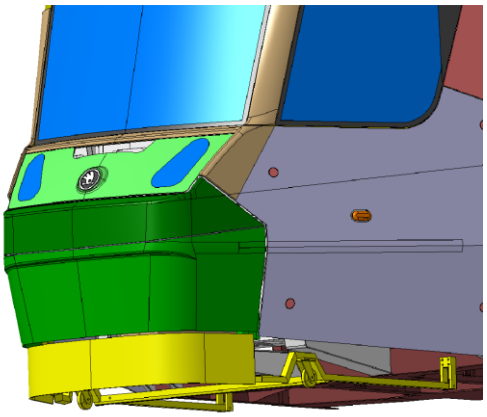
An example of a possible arrangement of the bumper and the two FUPs is represented by the following figure:



The FUPs solution can be carried out, for example, by the following methods, which, for several reasons, are not sufficiently functional. The examples serve only for initial inspiration.

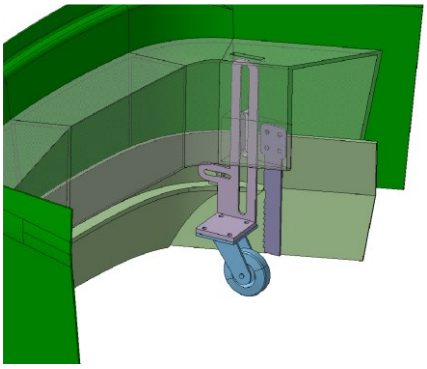






7. Adjustable FUP, FUP adjustment

Lifting the some FUP barrier when entering the vertical arc by mechanical means can be done, for example, in this way.



In this solution, the intent to fix the barrier in the event of an external force caused by moving the tramcar vehicle to an obstacle is visible.

8. General requirements

When designing the system, its reliability, overall simplicity and integrity with other vehicle parts, low weight, easy maintenance, reliable and easy set-up, etc. is important to take into account.

9. Configuration limits

There are no limits except for functional and technical-economical logic.

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product manager & chief engineer

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