Concepts and effectiveness of Derailment Detection Devices

The simulation of the accident occurred in Formia railway station

Hypothesis of use of DDD

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Viareggio – Simulation with DDD

Accident occurred in Formia railway station

25 Jun 2013
time 02:41

The freight train consisting of 17 empty wagons (type 152 Laaers) for the carriage of motor vehicles derailed at km 118 + 648 of the Rome-Naples line in the tunnel named Vivola.

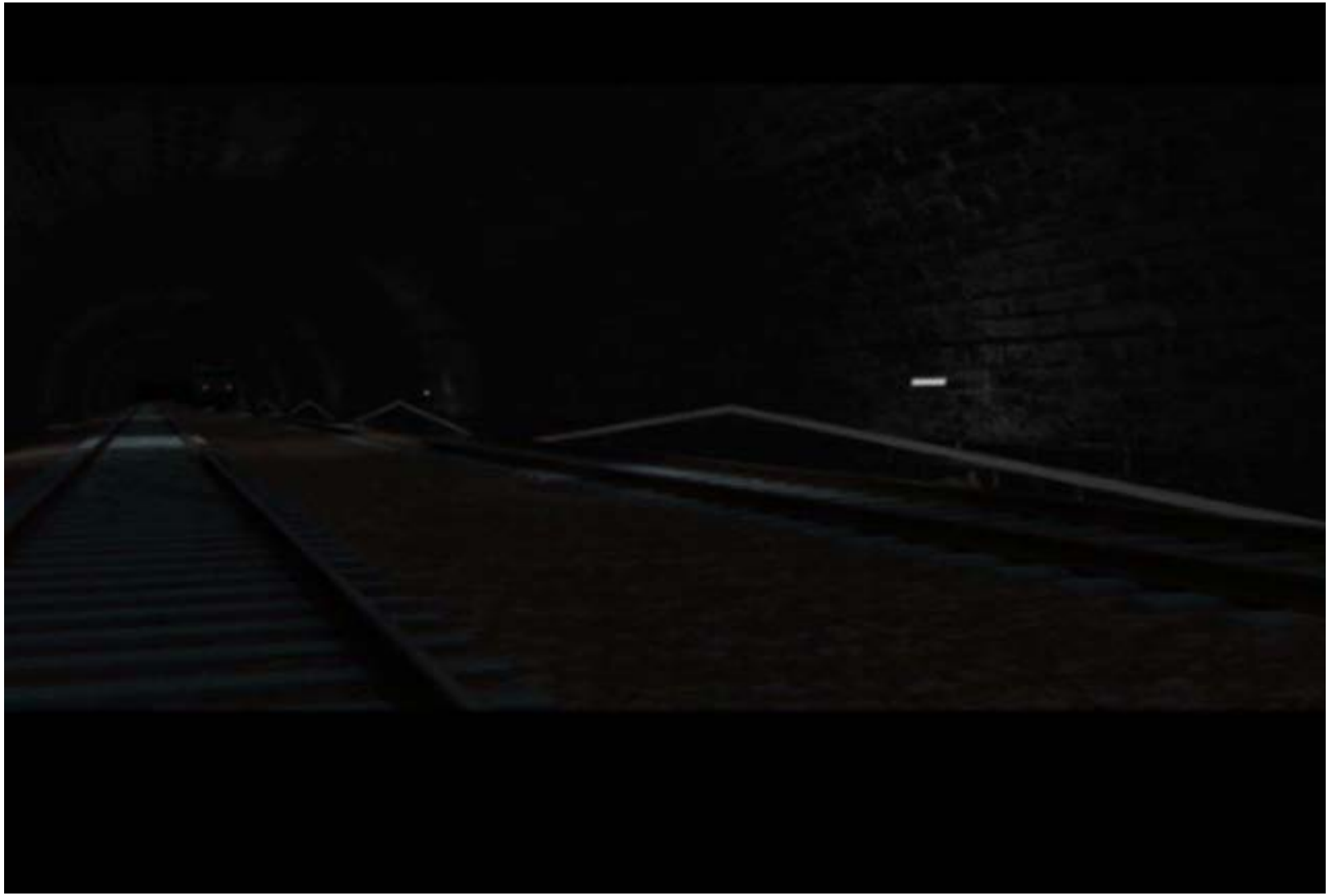
Continuing the run for about 9 km, the last four wagons (8 half-wagons) invaded and partially destroyed the passengers' platforms of the station.

The crossing of the train on a switch triggered the sudden movement of wagons from the seat track.

The train stopped at km 127 + 842 of the Rome-Naples line (Formia station) for the rip of the pipeline pneumatic braking.

Driver didn't have any perception of the occurred derailment before the braking final action.

Rendering 3D – Derailment without DDD



All damaged sleepers and *balises* SCMT (ATP system) from the point of derailment at the station of Formia Gaeta

The condition of the infrastructure from the point of derailment at the station of Formia

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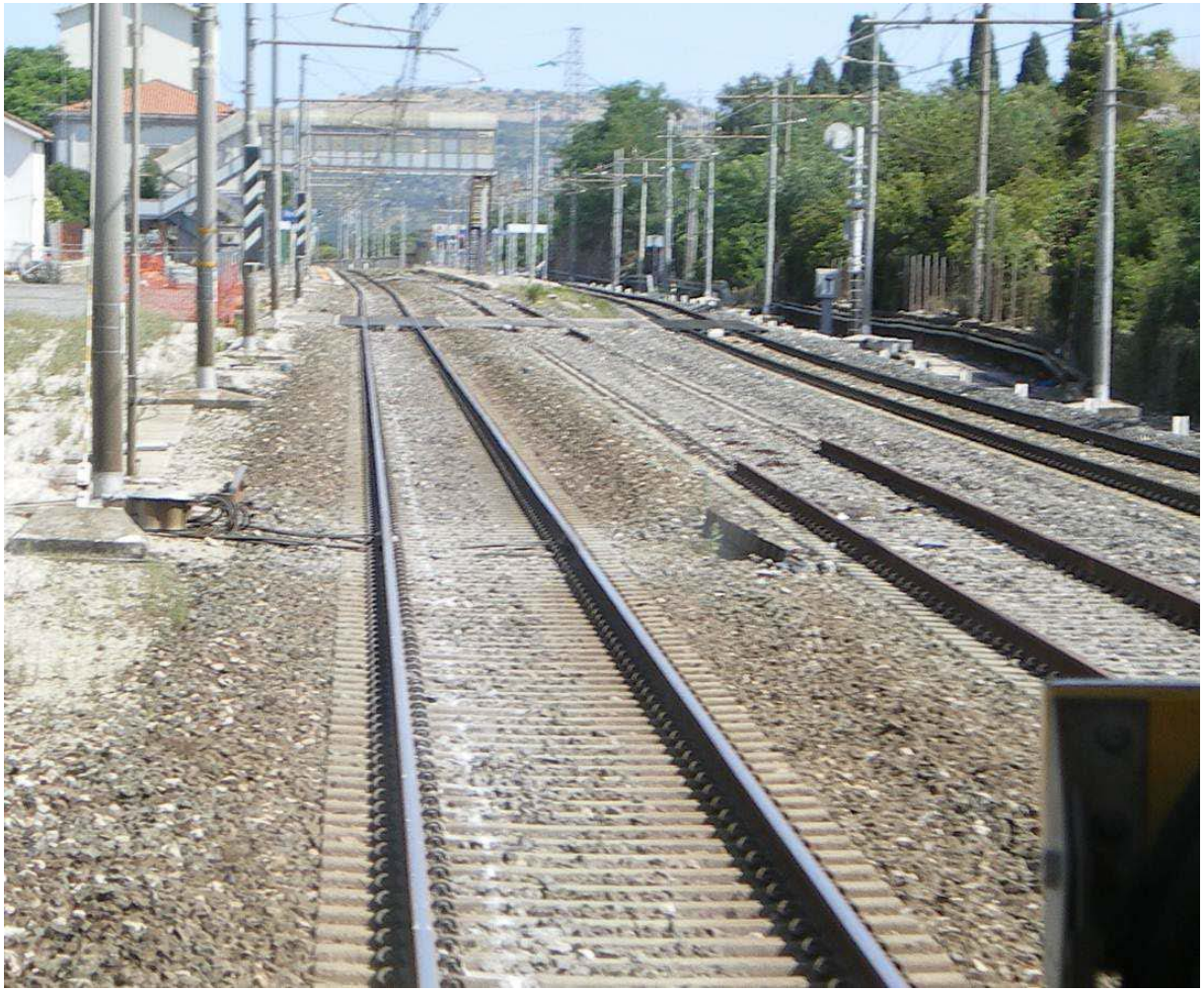
The condition of the infrastructure – Itri station



The station shows considerable damage to the railway armament between III and V rail, and to the train control systems.

The platform III has been heavily damaged for a length of about 100 meters and the wagon was stopped in its movement from the pole of the electric supply, which has also been partially destroyed itself.

Station of Formia Gaeta - conditions after derailment

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Statistical evaluation of the risk for the users' station (passengers) in consequence of the accident.

A possible methodological approach

Station of Formia - Gaeta (elements of classification for the model)

The stations in Italy are classified in the Italian Railway National on the basis of objective evaluation parameters:

- Plant size
- Attendance or the number of passengers and simple travellers who daily engage the rail system
- Interchange capacity, i.e. the ability of a rail system to connect, interact and operate with other public transport system

The railway station of Formia - Gaeta is classified as a railway plant of “medium / large size” characterized by a high level of attendance (> 10,000 average visitors / day) and passenger services of high quality for long, medium and short distance.

Traffic data

In the station of Formia - Gaeta the daily average transit number is :

- total 144 trains (data source RFI)
- 18 freight trains (data source RFI) (of which 15 are interfering with the passenger train schedule)
- therefore more than 12% of the circulating trains are freight trains

The time of average stay in the platforms has been evaulated in 12 minutes through a behavioral study (based on the Erlang distribution for the arrival of users in the station)

The users usually wait for reasons due to interchange delay between regional trains, local and long distance ones in this station.

The configuration and size of the platform implies an almost totally homogeneous distribution of the passengers on the platforms during the waiting time.

A possible methodological approach

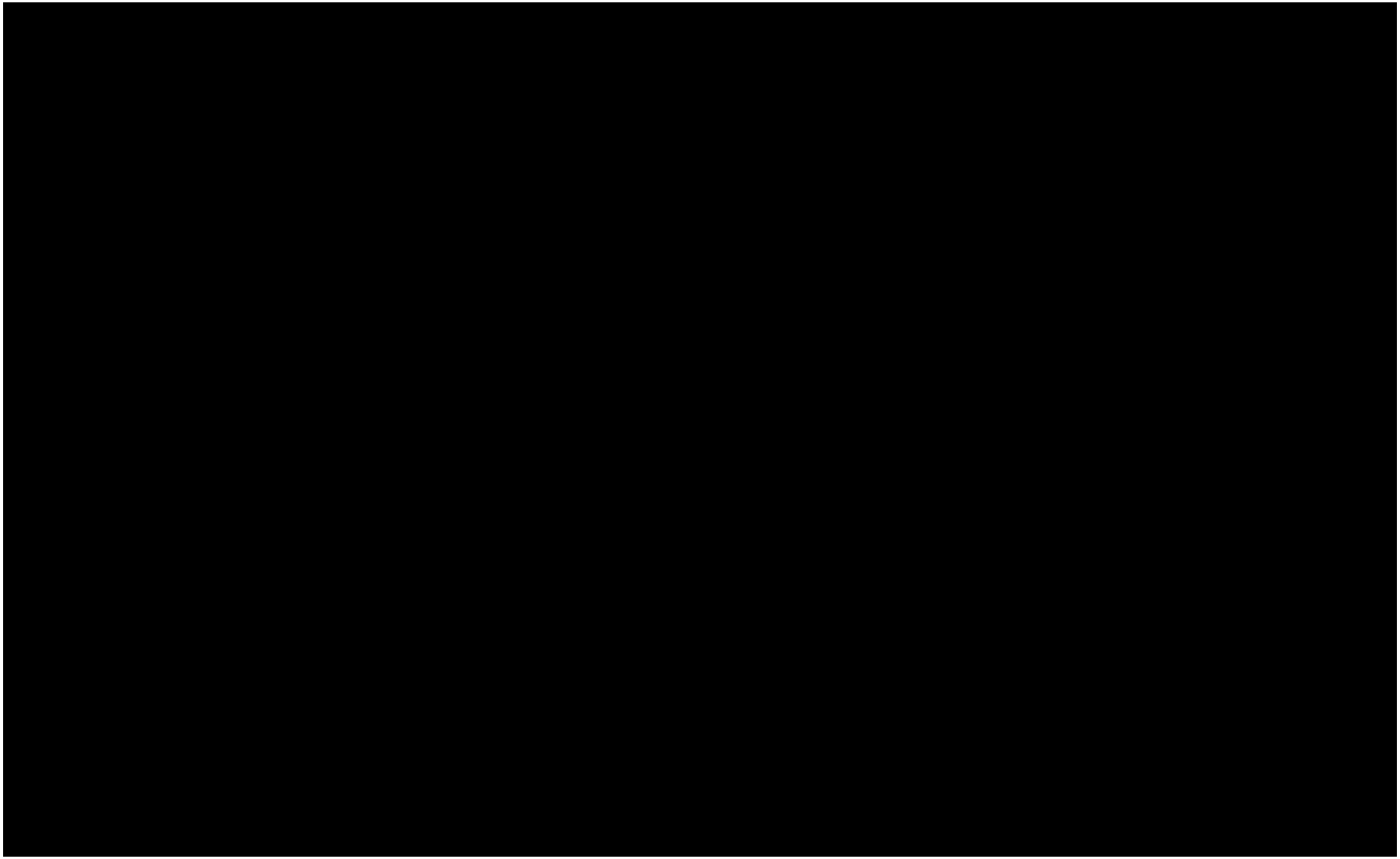
- It was evaluated as a “risk area” for this kind of impacts, the 18% of the total extension of the platform area of the station identifying and evaluating a coefficient of “potential extension” of damage **(a)**
- It was estimated in about 83% the probability that a freight train can pass through the station with passengers present on the platform. This value was derived after considering the operational plan of the station in a 20 days’ series. Probability of interference is defined by a coefficient **(k)**
- It was considered in 20.5 hours (decimal system) the time range of the presence of travelers on the platform. Dividing the average time of occupancy of 12 minutes for the time period of 20.5 hours it results a probability of “presence on the platforms” consequent to each single traveler of 0.0097 **(p)**

Multiplying the minimum average number of passengers during the day for the coefficients listed in the model, we obtain

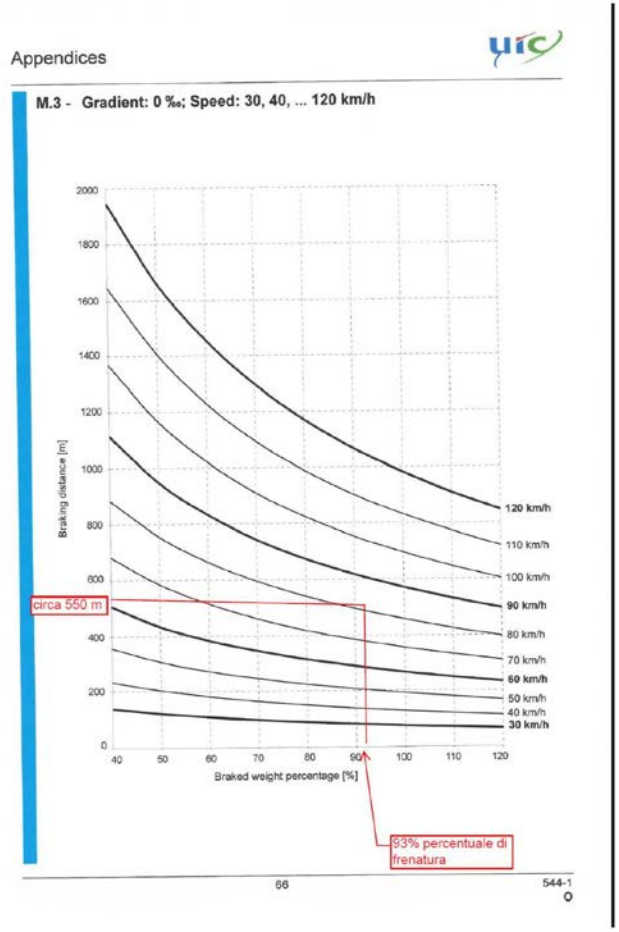
$$10.000 * a * k * p = 14.57$$

"*average expected value of people potentially affected by the accident*"

Derailment with DDD



Calculating the braking distance



The calculation of the braking distance (550 m) was obtained by considering

-the speed of the train at the time of the derailment 82 kmph (from Driving Information System)
- Brake mass percentage of 93%
- Line in plan

Using f the UIC Fiche 544-1 "Brakes - Braking power 'attached M3 page 66 we get the normal braking distance under normal braking .

The distance calculated is confirmed in the DIS data.

By calculating the stopping distance with the table UIC we obtain an overestimated value compared to a true emergency stop

In the case of activation, the DDD device inducts the opening in the general conduct equivalent to the rupture of a flexible braking pipeline.

In this accident, this breaking of the pipeline occurred just after the passing of the first switches (1a / 1b)

In all the cases the driver (following the operating procedure) when he detects the loss of pressure in the pipeline (and the consequent intervention of the brake), he must activate also from his cockpit the “rapid braking” that has already been activated by the rupture of conduct or by the intervention of DDDs when installed.

A “derailment emergency brake override” makes no sense because all relevant regulations require a stop in case of a derailment (e.g. TSI SRT says at 4.4.2.: “…except a derailment, that requires an immediate stop.”). It is a completely different situation in comparison to the passenger alarm emergency brake override and the running capability in case of fire on board.

Conclusion

The intervention of the DDD would have stopped the train at about 550 meters with the only damage of about 600 meters of track (sleepers and local technological systems) for an estimated cost of € 126,000.00 (€ 210,000.00 / km) instead of the total material costs suffered, more than € 4,000,000.00, over a length of 9200 meters including the damage in the station to the control systems and to the rolling stocks

The indirect damage caused by the delay of the trains are an additional cost generated by the activation of substitute services.

A possible quantification of the expected value of serious harm (death) to people it can be estimated in 21,8 M€ taking into account a mean value of human life for Italy of 1,5 M€

Damages quantification

Damages:

Rolling stocks	502.160,00 €
railway line	2.053.707,00 €
station	1.322.606,41 €
Expected statistical value of damages to people	**21,8 M€**

Many thanks for 3D Mash and Animation

the rendering coordinator Mr. Salvatore Valese

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Thanks for your kind attention