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In the design of a new-generation locomotive, an integrated passive safety system (PSS) must be considered to protect passengers and a train staff at probable accidental collisions. The paper discusses a scenario of a collision between the reference train and 80-ton freight car at 36 km an hour. The reference train includes the locomotive equipped by SSP with energy absorption devices (EAD), and the 80-ton freight car. This scenario is provided by the European standard EN 15227. The research purpose is to develop the EAD for new-generation passenger 90-123-ton locomotives. To determine the EAD integral parameters, namely the power intensity, a dynamic load of the locomotive is studied using a mathematical discrete-mass model. The novelty of this model is to improve the power characteristic of interactions between vehicles taking into accounts the operation of the absorbing devices of shifted automatic couplers and EAD, as well as the possibility of plastic deformation occurring in the EAD design and vehicles. The paper also presents a new finite element model of the EAD plastic deformation at impact. This model has been used to develop the EAD with the power intensity of 0.95 MJ and to select the EAD parameters. It is shown that the two energy-absorbing device installed at ends of the locomotive can provide the collision scenario in accordance with the requirements of European standard EN 15227 and the developed concept of the passive safety for passenger rolling stock operating on railways with 1520 mm gauge.

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2008 . EN 15227 [1]. -

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[3 – 7]. -

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3. -

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(push-back

coupler),

[8 – 12]. -

[3 – 9]. , , -

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                                                                    Alstom, Bombardier
Transportation, Dellner, Siemens, Voith Turbo, Amtrak, PESA   -
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                        EN 15227   -
                                                                    [13].   -
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                              80   36   / .   -
                                                 EN 15227   -
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                   [13].   -
                   80 .
               -3   -5   ,   -
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                    -3   -5 .   ,,
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$V = 36$ км/ч

3   2   1

80 т   80 т

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                                                 :
           –   0   0,01   0 F_1 ;
           –   0,01   0,2 F_1 ;
           –   0,2   0,21 F_1 F_2 ;
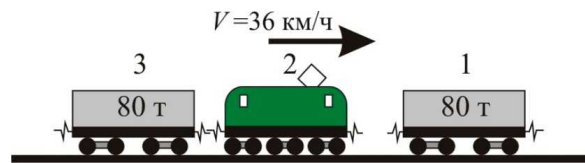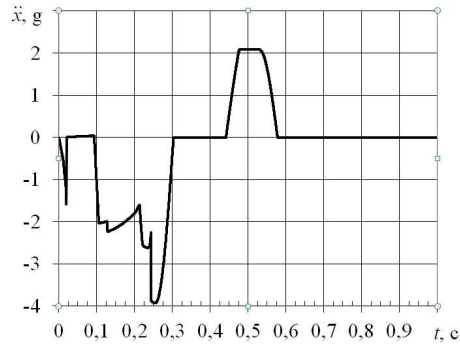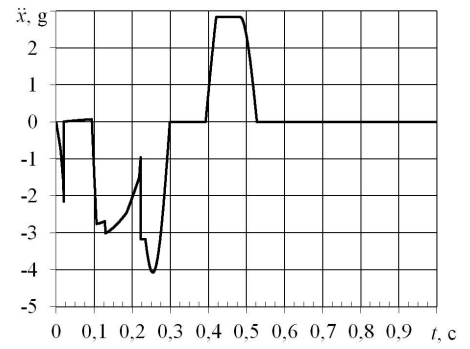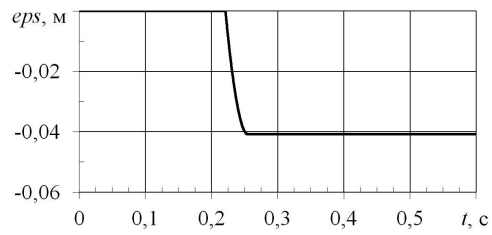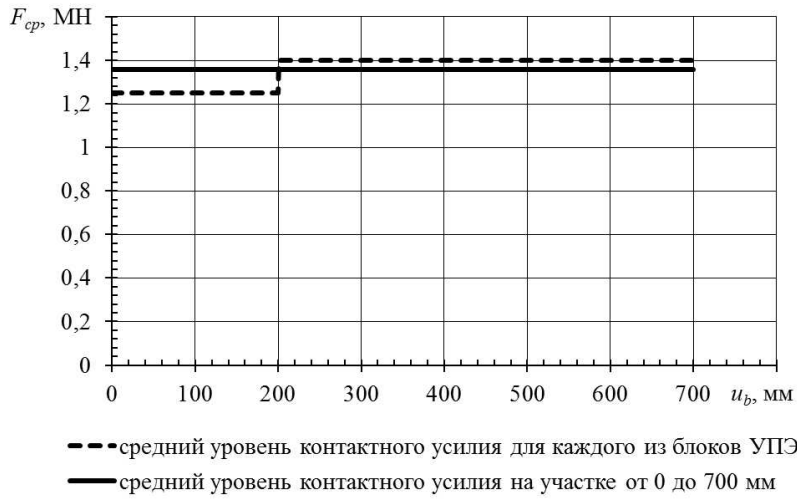   –   0,21   0,7 F_2 ;

                              $F_1 = 0,9$ $F_1 = 1,25$,   -
                                             0,9   0,95   .
F_2 1,4   .
                         ,   -

4,2   [13],   .
                                             ,   90

EN 15227 [1]   123   ,
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1520   .   100 .

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[14]

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0,9   .   ,

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90   ,

5,31   , 4,91   4,68   .

0,95   .

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M ,		$\ddot{x}_л, g$	eps,
	$S_л$,		
123	-4,89	4,0	-0,04
100	-4,43	4,4	-0,02
90	-3,70	4,0	0,00

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123 .   . 2,)   3,)   ,

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а)

б)

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а)

б)
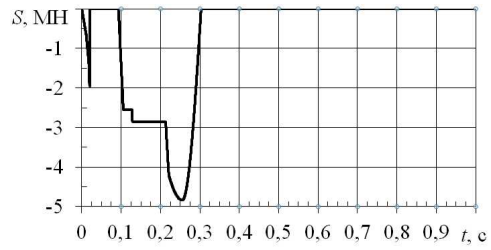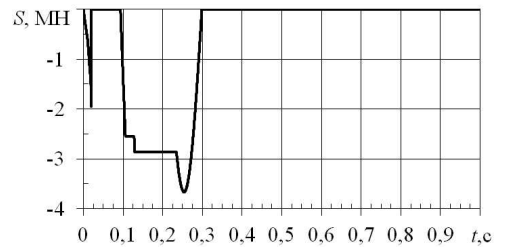
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123 ' 100 ,   ,
                                                          0,05   [1].

90   – 123 '   c   0,95   -

                                        EN 15227   -
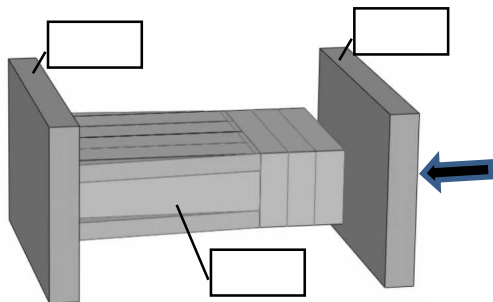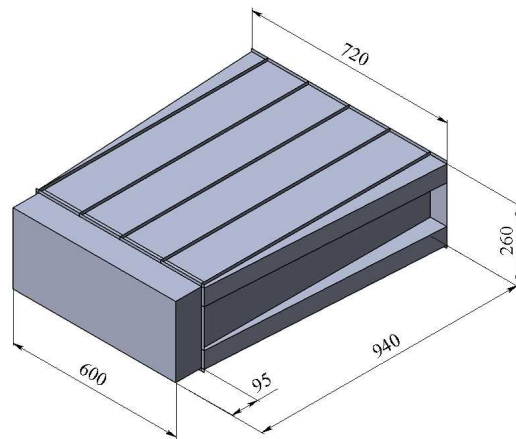
        1520   .

                                                          ,
0,95   .

                                    .   -

76

-   [15, 16]
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-
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$M_b = 80$ $V_b = 36$ /   (
[1]).   , . .   -
$F_{ср}$,   -
, u_b
,   . 5.

$F_{ср}$, МН

- - - - средний уровень контактного усилия для каждого из блоков УПЭ

———— средний уровень контактного усилия на участке от 0 до 700 мм

. 5

,   . 5,
0   u_b 200   1,25   ,
$200 < u_b$ 700 $-1,4$.
0   u_b 700   1,36   .

-
.   -   [15, 16]   -

-                        $M_b = 80$ $V_b = 36$ / .
. 6.

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E   ,   (F   -

u_b).   -

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. 7   . 8

(1 2). 1 -

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80   ,   35 −   85   .   −

30   .   ,   −

0,6   .   -

10   .

2   -

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20   1.   2

− 8   .   ,   − 2,2   .   -

2 − 6,6   .

−   08 σ_T =

175   .   -   :

$\rho = 7{,}8{\cdot}10^3$ / ^{3}; $E_e = 2{,}03{\cdot}10^5$;   -

78
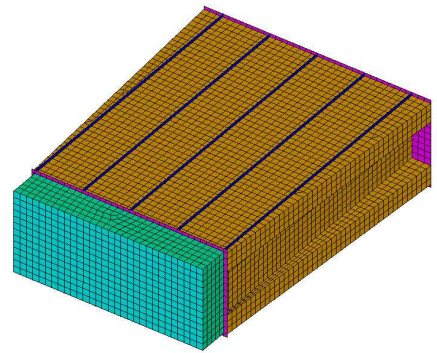
$\sigma_T = 175$; $\mu = 0,3;$ -

$E_T = 589$;   -

$C = 205$ $P = 4,59;$

1 $\varepsilon_p = 0,4,$ 2

$\varepsilon_p = 0,6.$

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1500×680×1000   1000×400×400   .   -

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$\rho = 7,8 \cdot 10^3$ / ^{3}; $E_e = 2,1 \cdot 10^5$;

$\mu = 0,3.$

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"   –   ”   19884   18406   .

17365   16381   .   -

1280   ,   – 1701.

100 – 400   ,

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36   / .

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u_b . 9.   ,   -

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$u_b,$. 10,   ,

E ,   ,   -

$u_b,$. 11.

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180   [17].   -

EN 15227 [1].

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0,95

700   .

0   u_b 700   (   )   1,36   ,   -

(. 5).   -

1,6   .

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,   ,   1,9   .   -

,   ,   3,2   ,

4,2   .

$u_b = 0$　　　　　$u_b = 100$　　　　　$u_b = 200$

$u_b = 300$　　　　　$u_b = 400$　　　　　$u_b = 500$

$u_b = 600$　　　　　$u_b = 700$　　　　　$u_b = 800$

. 9

контактное усилие (без фильтрации)

средний уровень контактного усилия (с фильтрацией)

контактное усилие (с фильтрацией)

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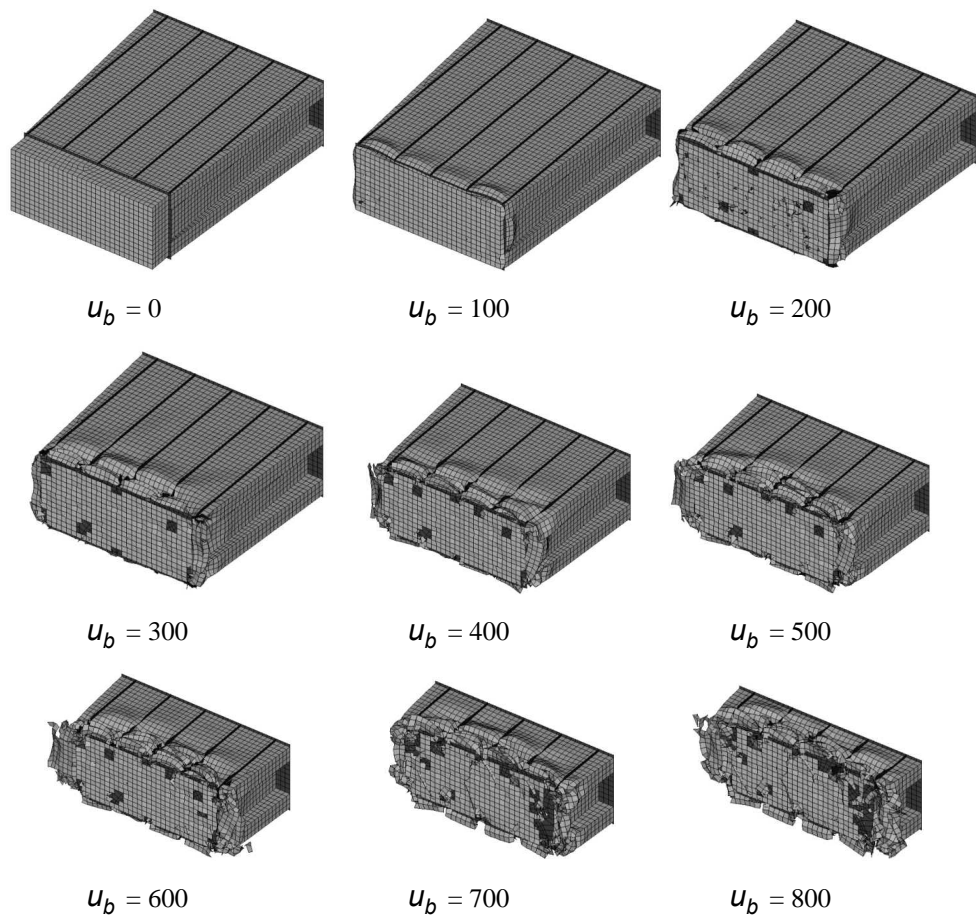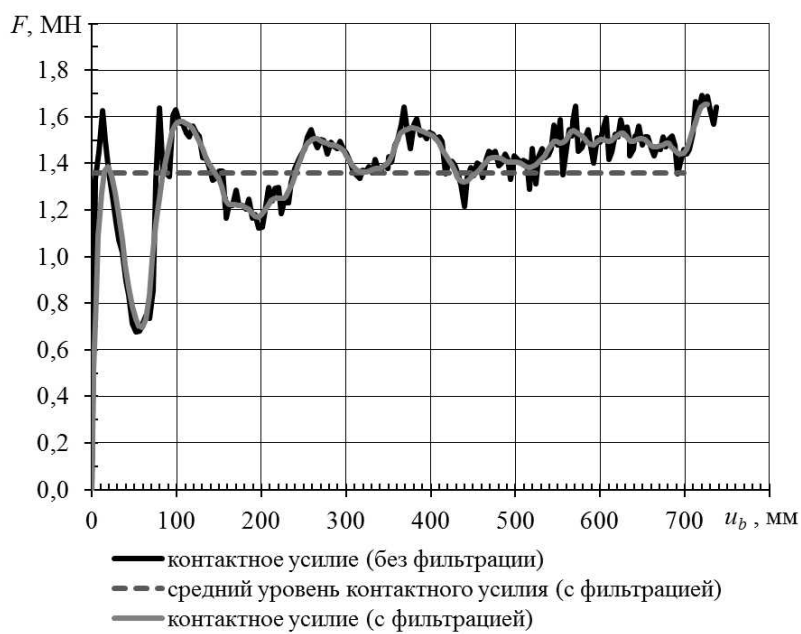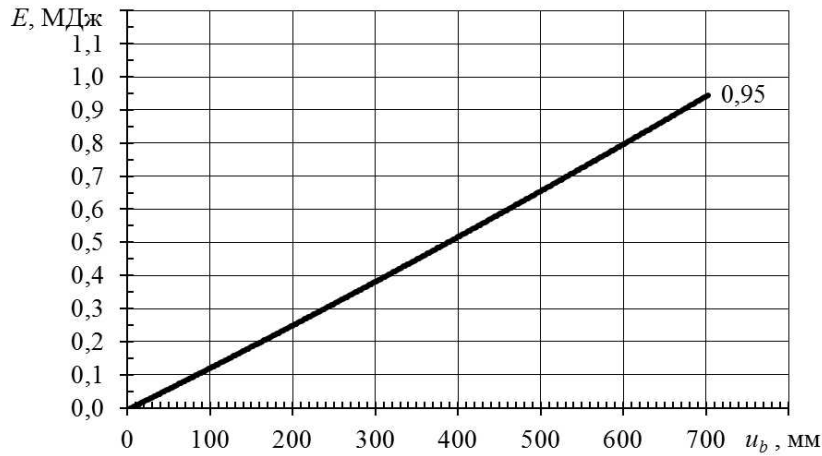
Рис. 11

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90 – 123

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EN 15227

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