Minimum mass = 74.7 t (2 car Class 156 as supplied by Transport Scotland)

Maximum mass = 335.16 t (8 car Class 380 as supplied by Transport Scotland)

Assumptions

Calculations are based on buffer stop type 22EB/3

Twin friction element of 3No. Bolt clamps, Torque 150 Nm under buffer stop on running rails

Breaking = 80 kJ/m

3 pairs of twin friction element (3 clamp bolts per element), Torque 150 Nm behind buffer stop

E = 240 kJ/m

Assume track is level - no potential energy considered

For Class 156

Vehicle Data — Train mass m = 74.7 t

Max. impact speed v = 10 km/h = 2.78 m/s

Deceleration d = $\leq$ 1.47 m/s^2 = 0.15 g

Kinetic energy at impact Ekin = $\frac{m \times v^2}{2} = \frac{74.7 \times 2.78^2}{2}$ = 289 kJ

Energy absorbtion of buffer stop:

Distance to second stage normally 3.5 m

Breaking capacity = 3.5 x 80 = 280 kJ

Distance required to arrest Clas 156 = 3.613 m

Therefore, contact with second stage would be minimal.

Check deceleration - $d = \frac{v^2}{2 \times s} = \frac{2.78^2}{2 \times 3.613}$ = 1.07 m/s^2

= 0.109 g Therefore, OK

Stopping distance = 3.613 m

Buffer length = 2.4 m

Additional retarders = 0 m

Total track occupancy = 6.013 m

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Work Section	Buffer Stop Calculations	Checker		Date	

For Class 380

Vehicle Data

Train mass	m =	335.16 t		
Max. impact speed	v =	10 km/h	=	2.78 m/s
Deceleration	d =	$\leq$ 1.47 m/s^2	=	0.15 g

Kinetic energy at impact Ekin = $\frac{m \times v^2}{2} = \frac{335.16 \times 2.78^2}{2}$ = 1295.125 kJ

Energy absorbtion of buffer stop (normal slave spacing):

First stage	3.5 x 80	(1 pair)	=	280 kJ
Second stage	0.5 x 160	(2 pairs)	=	80 kJ
Third stage	0.5 x 240	(3 pairs)	=	120 kJ
Fourth stage	2.6 x 320	(4 pairs)	=	832 kJ
s =	7.1 m		=	1312 kJ

Check deceleration - $d = \frac{v^2}{2 \times s} = \frac{2.78^2}{2 \times 7.1}$ = 0.544 m/s^2

= 0.055 g Therefore, OK

Total occupancy for normal slave spacing and normal number of slaves

Stopping distance = 7.1 m

Buffer length = 2.4 m

Additional retarders = 0.75 m

Total track occupancy = 10.25 m

10.25 m would give Deceleration value of 0.055 g

0.15 g is allowable

Energy absorbtion of buffer stop (adding 1 No. pair of slaves at each location):

First stage	3.5 x 80	(1 pair)	=	280 kJ
Second stage	0.5 x 240	(3 pairs)	=	120 kJ
Third stage	0.5 x 400	(5 pairs)	=	200 kJ
Fourth stage	1.5 x 560	(7 pairs)	=	840 kJ
s =	6 m		=	1440 kJ

Check deceleration - $d = \frac{v^2}{2 \times s} = \frac{2.78^2}{2 \times 6}$ = 0.644 m/s^2

= 0.065 g Therefore, OK

Stopping distance = 6 m

Buffer length = 2.4 m

Additional retarders = 1.5 m

Total track occupancy = 9.9 m

Energy absorbtion of buffer stop (adding 2 No. pair of slaves at each location):

First stage	3.5 x 80	(1 pair)	=	280 kJ
Second stage	0.5 x 400	(5 pairs)	=	200 kJ
Third stage	0.5 x 560	(7 pairs)	=	280 kJ
Fourth stage	0.7 x 880	(11 pairs)	=	616 kJ
s =	5.2 m		=	1736 kJ

Check deceleration - $d = \frac{v^2}{2 \times s} = \frac{2.78^2}{2 \times 7.1}$ = 0.743 m/s^2

= 0.076 g Therefore, OK

Total occupancy for normal slave spacing and normal number of slaves

Stopping distance = 5.2 m

Buffer length = 2.4 m

Additional retarders = 2.75 m

Total track occupancy = 10.35 m