A COST EFFECTIVE SOLUTION FOR MECHANICAL SPRING BUFFERS IN ELEVATORS IN COMPLIANCE WITH IS 17900

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ABSTRACT

IS 17900 issued by the Bureau of Indian Standards comes with changes in requirements for mechanical spring buffers and introduces stricter requirements for elevator safety and performance. As elevator manufacturers adapt to these changes, ensuring compliance while maintaining cost efficiency is crucial. This paper examines the updated standard and demonstrates how the advanced manufacturing processes at Modern Engineering and Spring Company (MESCO Springs) enable full compliance without increasing costs.

As per IS 17900 (5.8.2), mechanical spring buffers must achieve a total stroke (minimum 65mm) of at least 0.135 v² (in meters) for 115% of the rated speed, while withstanding a static load of 2.5 times the combined mass of the car and its rated load. Our spring buffers with a minimum stroke of 67 mm with load capacities up to 8200 kgs meet these requirements for elevators carrying 26 passengers and 1.0 m/s. Through optimized material usage and precision engineering, we ensure compliance with these critical safety benchmarks while maintaining cost-effective production.

By aligning with the new standard, our springs provide a seamless transition for industry stakeholders, ensuring enhanced durability, safety, and operational efficiency. This paper highlights the role of process innovation in delivering a market-ready solution that meets evolving industry demands. This paper also explores the rigorous load vs deflection testing procedures carried out for each batch of the springs.

1. INTRODUCTION

The elevator buffer is a critical safety component designed to slow down and absorb impact energy when the elevator reaches the bottom of the shaft at excessive speed, helping to prevent serious passenger accidents and prevents structural damage to the elevator (Zeng, 2024). There are 3 types of buffering systems: spring buffers, elastomeric buffers and hydraulic buffers. According to IS 17900 hydraulic buffers may be used for all car speeds, but elastomeric buffers and spring buffers cannot be used for car speeds over 1.0 m/s.

The Bureau of Indian Standards recently introduced IS 17900 (Bureau of Indian Standards, 2022), which outlines updated safety and performance requirements for elevators, including more stringent criteria for buffers with linear load-deflection characteristics (spring buffers). The standard mandates specific minimum stroke and load capacity based on the gravity stopping distance. This shift aims to bring elevator component design to global standards and ensure higher reliability, especially as the market expands into less regulated segments.

India's rapid urbanisation and expanding middle class have driven significant investment in industrial, commercial, and residential development (Purohit, 2023). The saturation of Tier 1 cities, coupled with high living costs, has led to a population shift toward Tier 2 and Tier 3 cities, where infrastructure development is accelerating alongside the rise of the gig economy (Vision IAS, 2022). This growth includes the construction of low to mid-rise buildings, which typically use elevators operating at speeds below 1 m/s and must remain cost-sensitive. For such applications, spring buffers offer a highly cost-effective and reliable safety solution.

Historically, OEM elevator manufacturers supplied their own spring buffer designs, many of which were legacy configurations carried over from earlier models. These designs were often not optimized, overengineered and varied significantly between manufacturers due to differences in elevator car and counterweight masses. As a result, spring buffers had to be customized for each OEM's specific requirements.

While (Alqoud, 2022) highlights how industries struggle to adopt modern Industrial IoT standards due to the challenges of retrofitting legacy systems, limited integration knowledge, and skill gaps, the vertical transportation industry has experienced similar constraints. Newer, optimized designs are often difficult to implement, with most stakeholders unwilling to take the risk of initiating design changes, especially in the absence of immediate regulatory or commercial pressure. This lack of structured understanding continues to limit both academic and industry-driven efforts to modernize legacy infrastructure effectively.

Furthermore, any attempt to alter these designs typically involves lengthy internal approval processes and formal engineering change requests, which discourages innovation or adaptation. This clearly underscores the need to standardize spring buffer designs that can perform reliably across a range of car weights and configurations, thereby simplifying selection and reducing development time for both large and small elevator manufacturers.

Notably, OEMs account for less than 40% of the market. The remainder is served by small and mid-sized elevator manufacturers, many of whom operate without in-house

engineering resources. These players will greatly benefit from pre-engineered, standardized solutions that are both easy to select and cost-effective.

A further concern is that some component suppliers use substandard materials or misapply design practices, leading to premature failure of buffers in the field. There is a pressing need for standardization and clear technical guidance to ensure that the performance of mechanical spring buffers aligns with the safety goals of IS 17900.

This paper first presents an overview of the relevant requirements under IS 17900, particularly the performance and safety benchmarks for mechanical spring buffers. It then outlines the design and specification of the spring buffers developed to meet these standards. The subsequent sections describe the design methodology and manufacturing process improvements that enable compliance without cost escalation, followed by testing results that validate performance under the new regulatory framework.

2. OVERVIEW OF IS 17900

The Bureau of Indian Standards has announced IS 17900, a new elevator code set to take effect on 22nd December 2025. From this date onward, all elevators installed in India will be required to comply with this standard. The existing codes IS 14665, IS 15785, and IS 14671 will be withdrawn. IS 17900 represents a significant shift for the industry. It introduces a unified, performance-based framework for elevator design, safety, and installation, aligning domestic regulations with international benchmarks. The standard addresses rising expectations for safety, quality, and consistency across the Indian real estate and construction sectors.

According to IS 17900 Part 1 clause 5.8.1 there are two types of buffers energy accumulation (elastomeric and spring buffers) and energy dissipation (hydraulic buffers). Further according to 5.8.1.5, energy accumulation buffers are split into linear and non-linear characteristics. Springs follow a linear load-deflection curve and elastomeric buffers follow complex non-linear load deflection curves – the buffer types are characterised based on their loading curves. We will dive deeper in the requirements for linear spring buffers.

Buffers have a working stroke across which they develop the resistive force to decelerate the moving car. 5.8.2.1.1.1 talks about this stroke and the minimum requirements for this stroke. For linear characteristic buffers, the minimum stroke shall be at least *twice the gravity stopping distance corresponding to 115% of the rated speed.* But the minimum buffer stroke must be 65mm. This formula to calculate buffer stroke is encapsulated in Equation 1.

$$L > \max\{0.135v^2, 0.065\} \qquad (1)$$

Where:

- L: minimum stroke of the buffer in metres
- V: rated speed of the elevator in m/s

In addition to meeting the minimum stroke requirement, the buffer must also be capable of withstanding the static load imposed during impact. As per Clause 5.8.2.1.1.2 of IS 17900, this load shall be between 2.5 and 4 times the combined weight of the elevator car and its rated passenger load.

Requirement	Clause	Parameter	Value
Minimum Stroke	5.8.2.1.1.1	Stroke (L)	$L > max\{0.135v^2,\ 0.065\}$
Static Load	5.8.2.1.1.2	Load (F)	$F > 2.5 \times (W_{car} + W_{load})$

Table 1: Summary of IS 17900 for Buffer Design requirements

All testing for spring buffers is carried out in-house at Modern Engineering and Spring Company (MESCO) using ASTM-calibrated equipment. Each spring buffer is individually load-tested and certified to ensure compliance with the requirements outlined in IS 17900. It is critical that the buffers return to their original height after being compressed under the car weight. *Table 1* summarizes the design requirements for the spring buffers.

In contrast, elastomeric buffers, due to their non-linear force-deflection characteristics, require more complex validation procedures. These tests often involve specialised equipment and are typically conducted at third-party accredited facilities, increasing both cost and lead time for certification.

3. SPRING DESIGN AND SPECIFICATIONS

3.1 Design Load Calculations

In India, the most common elevator speeds are 0.7 m/s and 1.0 m/s. Elevator manufacturers generally offer capacities ranging from 6 to 26 passengers. This creates a wide range of possible loads due to differences not just in the number of passengers, but also in the construction of the elevator car itself. Since each combination of speed and capacity requires proper buffering, we designed buffers to cover all combinations within this range. We call our series of buffers the *Elevator Spring Buffer Series: ESB-07-XXXX* and *ESB-10-XXXX* for 0.7 m/s and 1.0 m/s car speeds where XXXX is the max load of the car plus passenger rounded off, this makes it easy for manufacturers to select the correct buffer based on car speed and total weight of the car and rated load.

While the passenger weight is standardized at 68 kg per person, the elevator car weight varies depending on its construction. Some elevators use minimal, lightweight structures, while others incorporate heavier materials such as mirrors, thick wooden rails, or decorative panels. These differences can significantly impact the total load acting on the buffer.

To capture this variation, we considered two cases for every passenger capacity: a light car and a heavy car. These values reflect the typical range found in the field.

- Light car: assumed to weigh 65% of the total passenger load
- Heavy car: assumed to weigh 85% of the total passenger load.

For each configuration, we first calculate the total passenger load based on the number of passengers. We then estimate the car weight using the above ratios and add it to the passenger load to get the total load. As required by Clause 5.8.2 of IS 17900, we apply a 2.5 safety factor to this total load to determine the design load the buffer must withstand.

The resulting values are tabulated in *Table 2* to serve as a clear reference for buffer selection. In *Table 2* the following variables are defined

- $N = number\ of\ passengers$
- $W_p = weight\ of\ passengers\ (68 * N)$
- $W_{light} = weight\ of\ light\ car\ (0.65 * W_p)$
- $W_{heavy} = weight\ of\ heavy\ car\ (0.85 * W_p)$
- $W_{total-light} = total\ weight\ of\ light\ car\ (W_p + W_{light})$
- $W_{total-heavy} = total\ weight\ of\ heavy\ car\ (W_p + W_{heavy})$
- $F_{design-light} = design\ load\ of\ light\ car\ (2.5 * W_{total-light})$
- $F_{design-heavy} = design\ load\ of\ heavy\ car\ (2.5 * W_{total-heavy})$

By accounting for both car weight and passenger capacity across two common elevator speeds, this approach ensures that the buffer design remains valid across a wide range of real-world conditions.

N	W_p	W_{light}	W_{heavy}	$W_{total-light}$	$W_{total-heavy}$	$F_{design-light}$	$F_{design-heavy}$
(nos)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)
6	408	265	347	673	755	1700	1900
8	544	354	462	898	1006	2250	2520
10	680	442	578	1122	1258	2800	3510
13	884	575	751	1459	1635	3650	4100
16	1088	707	925	1795	2013	4500	5040
20	1360	884	1156	2244	2516	5600	6300
26	1768	1149	1503	2917	3271	7300	8200

Table 2: Design Load Calculations for 6 to 26 passengers

3.2 Stroke Calculations and Buffer Design

The required stroke of a mechanical spring buffer is directly related to the rated speed of the elevator. As per IS 17900, the minimum stroke is calculated using Equation 1. This equation defines the least amount of travel required to safely decelerate the elevator at 115% of its rated speed.

However, our application demands that a single buffer must work across a wide range of elevator configurations, from light to heavy car designs, and across passenger capacities. To address this, we have designed the spring buffer with an extended total stroke that includes:

- Minimum required stroke to meet the lightest operating load under the speed-specific requirement (given by Equation 1).
- Additional stroke to cover the increased deflection needed for the heaviest load scenario.
- Reserve travel of 5 mm, which serves as a safety buffer in case of accidental overloading or extreme cases. This reserve ensures that the spring never bottoms out under any compliant condition.

By designing the buffer to operate within this extended stroke range, we ensure that compliance, performance, and safety are maintained for all possible use cases, while keeping the spring buffer design standardized and versatile. S_{min} and S_{max} represent the stroke of the buffer needed to cover the load $F_{design-light}$ and $F_{design-heavy}$ respectively. When S_{min} is calculated as per Equation 1 for $v = 0.7 m/s$ and $v = 1.0\ m/s$ we get

- $S_{min} = 0.135 * (0.7)^2 = 66.15 mm$
- $S_{min} = 0.135 * (1.0)^2 = 135 mm$

Design strokes are covered in *Table 3* and *Table 4* for 0.7 m/s and 1.0 m/s car speed respectively. Once the required buffer stroke and corresponding loads are established, we calculated the spring rate necessary to meet these conditions. The design spring rate was calculated using the formula

$$k = (F_{design-heavy} - F_{design-light})/(S_{max} - S_{min}) \tag{2}$$

Buffer Name	N	$F_{design-light}$	$F_{design-heavy}$	S_{min}	S_{max}	k (spring rate)
	(nos)	(kg)	(kg)	(mm)	(mm)	(kg/mm)
ESB-07-750	6	1700	1900	67	75	25.00
ESB-07-1000	8	2250	2520	67	75	33.75
ESB-07-1250	10	2800	3150	67	75	43.75
ESB-07-1600	13	3650	4100	67	75	56.25
ESB-07-2000	16	4500	5040	67	75	67.50
ESB-07-2500	20	5600	6300	67	75	87.50

ESB-07-3300	26	7300	8200	67	75	112.50
Maximum Stroke (Solid Deflection): 80mm						

Table 3: Stroke Calculations for 0.7 m/s car speeds

Buffer Name	N	$F_{design-light}$	$F_{design-heavy}$	S_{min}	S_{max}	k (spring rate)
	(nos)	(kg)	(kg)	(mm)	(mm)	(kg/mm)
ESB-10-750	6	1700	1900	135	150	13.33
ESB-10-1000	8	2250	2520	135	150	18.00
ESB-10-1250	10	2800	3150	135	150	23.33
ESB-10-1600	13	3650	4100	135	150	30.00
ESB-10-2000	16	4500	5040	135	150	36.00
ESB-10-2500	20	5600	6300	135	150	46.67
ESB-10-3300	26	7300	8200	135	150	60.00
Maximum Stroke (Solid Deflection): 155mm						

Table 4: Stroke Calculations for 1.0 m/s car speeds

To achieve the required spring rates, we selected wire diameters ranging from 16 mm to 28 mm and outer diameters from 107 mm to 137 mm. These sizes are well within the capacity of our existing tooling and allow us to cover the entire range of elevator loads and speeds under IS 17900. A complete list of specifications of the ESB-07-XXXX and ESB-10-XXXX series is provided in the appendix.

A key part of our cost-efficiency lies in standardization. For any given rated load, we fix the wire diameter and outside diameter for the same load across different car speeds. The only parameter we vary is the free height of the spring, which adjusts the total stroke to meet the demands of different speeds. This approach simplifies production without compromising performance. By keeping the geometry fixed:

- We reduce setup time between batches
- Tooling and raw material procurement become streamlined
- Inspection and quality control processes are repeatable and faster
- Inventory complexity is minimized

This process-level innovation enables us to deliver compliant products at lower cost while maintaining high consistency. It also benefits end users and elevator OEMs by making buffer sourcing more predictable and reducing lead times. In an industry where

component-level customisation is common and often expensive, our approach delivers a reliable, standard solution without adding engineering overhead.

4. MANUFACTURING PROCESS

The manufacturing process for our elevator spring buffers is designed to ensure high performance, consistent quality, and long-term reliability under the safety requirements of IS 17900. Each stage has been optimized through controlled, repeatable steps. The focus remains on process discipline and cost-effective standardization, without compromising mechanical integrity.

4.1 Material Selection

We use only the highest grade of **SAE 6150 or SAE 5160 spring steel**, known for its excellent fatigue resistance, toughness, and hardenability (Yamada, 2007). The wire is **centreless ground** and finished to a **bright surface**, ensuring minimal surface imperfections. This step is critical, as even small surface defects can significantly reduce fatigue life in applications like spring buffers.

4.2 Coiling and Pitch Control

Springs are coiled using a fully automatic CNC pitching machine, which allows precise control over the pitch profile. This includes programmable acceleration and deceleration slopes, ensuring the top and bottom coils are closed onto the preceding coils correctly. We have developed our own coiling machine making it extremely easy for the operators to coil springs perfectly the first time itself.

4.3 Heat Treatment

The heat treatment process is carried out in ASTM-calibrated electric furnaces, ensuring uniform heat penetration throughout the wire section. The springs are automatically quenched within 12s after being removed from the furnace using automatic quenching baskets. This ensures optimal hardness without inducing internal cracks. The springs are then tempered within 2 hours to relieve quenching stresses and enhance ductility.

4.4 Top and Bottom Coil Grinding

After heat treatment, springs undergo grinding at top and bottom coils to ensure parallelism. The coils are ground until the tip thickness is 35% of the wire. All springs meet a squareness and parallelism tolerance of 1%.

4.5 Fatigue and Surface Treatment

To enhance fatigue life, springs are:

- Fully compressed to solid height for 10 full compression cycles to stabilize geometry
- Shot peened with 100% coverage to introduce surface compressive stresses
- Stress relieved to remove residual forming and heat treatment stresses

A polyurethane (PU) coating is applied for corrosion resistance and aesthetic finish.

4.6 Inspection and Quality Assurance

Each spring is subjected to:

- 100% load-deflection testing to ensure compliance with design tolerances
- Magnetic Particle Inspection (MPI) using central conductor method to detect any cracks or surface defects post-hardening
- 100% marking of top coil with part number and test certificate number

This stringent quality control framework ensures that every batch meets mechanical and safety requirements, while maintaining production efficiency and cost control.

5. RESULTS

We have prepared 5 samples of each of the buffers ranging from 6 to 26 passengers for 0.7 m/s and 1.0 m/s car speeds. We subjected these samples to the following tests using our special purpose machinery shown in *Figure 1*.

- 10 solid compression cycles
- Load-Deflection Testing

Figure 1: 20T Load-Deflection Testing Machine (left); Scragging Hydraulic Press (right)

The load-deflection testing machine automatically generated force-displacement readings for each sample. The data was averaged across the five samples for each variant, and consolidated results were tabulated. Please find complete testing data for ESB-07-XXXX and ESB-10-XXXX variants in Table 5 and Table 6. $F1$ and $F2$ represent the buffer stroke; $P1$ and $P2$ represent the load at the respective stroke.

Item	$F1 = 67mm$	$F2 = 75mm$
	P1 (Kg)	P2 (Kg)
ESB-07-750	1723	1967
ESB-07-1000	2278	2584
ESB-07-1250	2901	3221
ESB-07-1600	3676	4114
ESB-07-2000	4513	5103

ESB-07-2500	5621	6312
ESB-07-3300	7351	8267

Table 5: Load-Deflection results of ESB-07-XXXX series buffers

Item	$F1 = 135\ mm$	$F2 = 150mm$
	P1 (Kg)	P2 (Kg)
ESB-10-750	1736	1988
ESB-10-1000	2312	2597
ESB-10-1250	2863	3210
ESB-10-1600	3691	4169
ESB-10-2000	4536	5096
ESB-10-2500	5665	6330
ESB-10-3300	7366	8214

Table 6: Load-Deflection results of ESB-10-XXXX series buffers

The load-deflection readings confirm that all tested spring buffers consistently achieved their target loads within the tolerance at the required deflections. There was no permanent deformation or permanent set observed in the springs. The sample springs came back to their original height even after the compression cycles and load-deflection testing. This demonstrates reliable compliance with the design parameters specified in Table 2 and the performance criteria under IS 17900.

6. CONCLUSION

The implementation of IS 17900 introduces stricter requirements for elevator safety, particularly in the design and performance of mechanical spring buffers. This paper has demonstrated that with focused process innovation rather than design complexity it is possible to meet these requirements while maintaining cost efficiency.

Through standardization of key parameters like wire diameter and outer diameter, and by varying only the spring height, we have developed a modular buffer system that supports a wide range of elevator configurations. This approach simplifies production, reduces inventory costs, and improves sourcing and reliability especially valuable in India's fast-growing Tier-2 and Tier-3 cities.

Comprehensive in-house testing across all passenger and speed variants confirmed that the buffers meet stroke and load requirements as per IS 17900. All samples passed fatigue and load-deflection tests using calibrated equipment, further validating the consistency of the manufacturing process.

As the industry transitions to the new code, this work offers a ready-to-deploy, scalable, and cost-effective solution. It serves not only OEMs but also smaller elevator manufacturers seeking compliance without added engineering burden.

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8. APPENDIX

Spring Buffer Specification Tables

The following tables provide the complete specifications for ESB-07-XXXX and ESB-10-XXXX. These include the spring dimensions, stroke and load values corresponding to various load capacities and rated speeds.

Item	Wire Dia	Outer Dia	Free Length	Load @ $F1 = 67\ mm$	Load @ $F2 = 75\ mm$
	$d\ (mm)$	$D_o\ (mm)$ $\pm 1.6mm$	$Lo\ (mm)$ $+10mm$	$P1\ (Kg)$ $\pm 10\%$	$P2\ (Kg)$ $\pm 10\%$
ESB-07-750	16	107	155	1699	1902
ESB-07-1000	18	116	163	2252	2520
ESB-07-1250	19	108	186	2848	3188
ESB-07-1600	21	117	191	3655	4092
ESB-07-2000	23	121	210	4498	5035
ESB-07-2500	25	128	218	5597	6266
ESB-07-3300	28	137	235	7312	8185
Working Stroke – 67mm to 75mm. Max Stroke 80mm					

Table A1: Specifications, tolerances and working stroke for ESB-07-XXXX series buffers

Item	Wire Dia	Outer Dia	Free Length	Load @ F1 = 135 mm	Load @ F2 = 150 mm
	$d\,(mm)$	$D_o\,(mm)$ $\pm 1.6mm$	$Lo\,(mm)$ $+10mm$	$P1\,(Kg)$ $\pm 10\%$	$P2\,(Kg)$ $\pm 10\%$
ESB-10-750	16	107	285	1699	1888
ESB-10-1000	18	116	297	2251	2501
ESB-10-1250	19	108	345	2850	3166
ESB-10-1600	21	117	351	3651	4057
ESB-10-2000	23	121	388	4501	5001
ESB-10-2500	25	128	398	5652	6280
ESB-10-3300	28	137	438	7324	8138
Working Stroke – 135mm to 150mm. Max Stroke 155mm					

Table A2: Specifications, tolerances and working stroke for ESB-10-XXXX series buffers

9. AUTHOR BIOGRAPHIES

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Aadiv is an Electronics and Telecommunication engineer from Veermata Jijabai Technological Institute, Mumbai. He has completed his masters in Robotics Engineering from Worcester Polytechnic Institute in 2023. He handles the business development and technical sales at Modern Engineering and Spring Company.

Nilesh Shah

Nilesh is a Machine Tools engineer from K.J Somiya College of Engineering, Mumbai. With over 30 years' experience in the steel and spring industry, he is a pioneer in spring technology, manufacturing and design. He oversees the operations at Modern Engineering and Spring Company. He led the development of the ESB series spring buffers since 2024.