COILED SPRING USED IN COACHING STOCK



INDIAN RAILWAYS

Presented by

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No. NC/07/AIIW/2015.

Dated: - 27th .March 2015

From: - SSE/NC AIIW

TO: - The Secretary General

IRCA/NDLS

Sub: - Takniki – president /IRCA Technical paper competition.

Ref:- Your letter No.ICN.915/Takniki.2015 Dt. 04.02.2015

With above reference the enclosed Takniki paper is submitted for your kind observation and further needful please.



Takniki paper

Sub: - Coil spring used in Primary and Secondary suspension of coaching stock.

Participation: - NC staff includes SSE NC. of carriage workshop Ajmer NWR.

Reference taken – 1) WD-01-HLS-94(REV- 3)

2) CGW0001 (REV – 4)

3) MENTINENCE MANUAL FOR BG COACHES

4) DAY TO DAY PRACTICAL WORK

Constance:- Definitions , History in brief , Suitability , Manufacturing and Coiling process , Dimensional check , Numeral fact .

Spring – It is a device which changes its shape within elastic limit when an external force is applied and returns to the original shape on the removed of applied force.

Type of Spring – Some common spring which are being used on rolling stock as under

1) - **Leaf spring** – It is a without coil having shallow arch shape.

2) - **Disc spring** - It is spring without coil shaped like truncated cone.

3)- **Air spring** – Provided in secondary suspension on coaching stock work's on the basis of Air pressure controlled by a labeling valve.

4) - **Coiled spring** – It consists of wire wound into a cylindrical or conical shape.

Some common forms are :-

A-**Compression spring** – It is a coil spring with space between successive coils. When a force applied the coils are pushed closer.

B-**Extension spring** – It is a coil spring whose coils are normally touch each other. When a force applied to stretch it the coil separate.

C- **Torsion spring** - It is a coil spring designed so the applied force twists the coil in to a tighter spiral.

5) - Materials with elastic property are also a kind of spring.

Invention & Development – Necessity is the mother of invention. Under this facts spring are be gain to invent early in third century B.C. Coiled springs which are being used in coaching stock are developed in early fifteen century by replacing the system of weight. In eighteenth century under Industrial revolution spurned the development of mass production techniques for making springs. During 1780s British locksmith Joseph used a spring winding machine in his factory with adaptation of a lathe equipped with a rod on which a reel of wire is wrapped development in coiled spring manufacturing is steel continue.

USES – Spring are being used frequently in machine, Automobile, Rolling stock (IR) and in the equipment used in day to day life.

Advantage –

1) It make the work essayer by obtaining maximum mechanical advantage in less effort .
2) It provides comfort during vertical and lateral occilations.
3) It save the adjoining components from damage possible due to load and Jerk thus provides their maximum life .
4) It help us providing/ adjusting and proper clearances and it thus reduces friction /hammering in between two adjoining components.

Coil springs which are being used in suspension arrangement of main line coaches on Indian railways are of closed ground end type. These are made of fine grained special quality spring to IS : 3195. It is responsibility of the manufacturer to ensure all the quality specified.

Manufacturing / coiling process – Bar preparation.

Row materials – Chrome silicon, Chrome vanadium.

Finished bar dia.'d'(mm)	Steel grade as per IS: 3195-92. Amendment No. 2 of 2000 or latest
$d \leq 30$	60Si7
$30 \leq d \leq 60$	52Cr4 Mo2V

The contents of Sulpher, Phosphorus and tramp elements should be as under.

Sulpher (S) 0.025% max.

Phosphorus (P) 0.025 % max.

Sn – Pb +As – 0.1% max.

The bar should have the following quality –

1) **Smooth and having specified length.**
2) **Straightening - should have straightened in the bar Straightening machine.**
3) **Peeling and centre less grinding – should be peeled and centre less grinded with surface finish up to 05 microns (IS: 3073). After this reduction in bar dia. should be 3% or 1mm. which is higher and straightness should be max.1mm/per metre length.**
4) **Should have tested for magnetic particle testing by fluorescent wet method.**
5) **Both end should have tapered with tip thickness be less than $1/4^{th}$ of dia.33 & less and $1/5^{th}$ for dia. more than 33mm.**
6) **Finished bar should have hot stamped with the following code on both tapered end.**
   - **A) Material code.**
   - **B) Manufacturer's initial code.**
   - **C) Month and Year of Manufacture.**
   - **D) Drawing code.**

Quality checks before coiling :-

1) **Hardness - should be as under**

Steel grade	Hardness HB max.	
	Untreated condition	Annealed condition
60SI7	255	245
52Cr4Mo2V	310	255

2) **Heterogeneity – micro etching test should be made for evaluating this internal defect as per IS: 7739.**
3) **Microscopic examination for evaluation of non metallic inclusion contact should be made.(IS:4163)**
4) **Average grain size should be to ASTM No.6 or finer as per ASTM/E-112.**
5) **Permissible depth of seam and lap in the bar should be d/100 or .4mm which is less as per test procedure IS: 3703.**
6) **Tolerance on diameter should be within +1% to – 0.8%.**

Non accept abilities of bar for coiling :- Steel bars with distortion, twist ,kinks seams ,folds, laps, crack, deep rooted seams ,holes, deep pits ,groves, excessive scaling, and internal defects like piping and segregations etc. are should not be accepted for coiling.

Coiling process

Coiling can be made either by Cold Winding or Hot Winding process.

1) **Cold Winding:-Wire/Bar dia. less than 18mm.can be coiled at room temperature on a spring winding matching provided with a lathe, an electric hand drill and mandrel on which a wire /bar is wrapped around with desired pitch or it can be made on a Central Navigation Computer (CNC).**

2)Hot Winding :- Wire/Bar dia. more than 18mm.is coiled with the help of a high speed automatic coiling and pitching machine . Bars are coiled on a pre heated mandrel with specific care so as minimum time lag between heating , coiling and starting of Quenching process. It is ensured that heated material remains in contact with air for minimum time to avoid oxidation. At the time of end closing of the spring it is ensured that the end gap between the tip and the adjacent effective coil is such that the tip dose not bite the effective coil under load or off load and the gap should gradually increased.

Heat treatment:- During coiling process stress develops with in materials. Hence heat treatment is given to remove stress and to allow the spring to maintain its caracteristic.

1) **Quenching: - Under this spring quenched in to a suitable quenching medium with maintained predetermined temperature limit in order to obtain optimum quenching condition.**
2) **Tempering : Springs are heated in a tempering furnace either oil fired or electric indirect heating with automatic temperature controller and recorder for sufficient time and up to desired predetermined temperature to provide hardness.**

Grade Steel	Hardening in oil 0C	Tempering 0C
60Si7	830------860	350------450
52Cr4Mo2V	830------860	350-------450

3) **Hardening: - The hardness of the spring should be 380 to 440 BHN for silico magnese and 415 to 460 for chrome moly springs. Hardness between surface and core as well as cross section should not more than 20 BHN with surface hardness be more. Depth of decarb should not exceed 0.5 % of bar dia.**

After completion of all above manufacturing process crack detection test is done in accordance with Appendix 'B ' of specifition UIC -822 on 100% spring.

Shot peeling :-Before use all springs are uniformly shot peeled as per IS:7001 to improve fatigue life of the springs.

Grouping and color coding :- All springs are compressed with specified working load to ensure their proper working as specified in drawing. Then they are painted with specified paint (one coat of zinc chromate primer to IS:2074 follow by one coat of Black Synthetic Enamel to IS:2932) for protection against corrosion and then color coding is done as specified for difference groups.

		Bar dia. (mm.)	Free Height (mm.)	Height under test load (mm.)	Test load (Kg)	Height as per color code /Group		
						Yellow (A) (mm.)	Blue (B) (mm.)	Green (C) (mm.)
AC COACH	AXLE BOX SPRING	33.5	375	264-282	2800	264-269	270-275	276-282
	BOLSTER SPRING	42	400	291-308	4800	291-296	297-303	304-308
NON AC COACH	AXLE BOX SPRING	33.5	260	279-295	2000	279-284	285-289	290-295
	BOLSTER SPRING	42	385	301-317	3300	301-305	306-311	312-317

Special :- Definitions and Numericals:-

A) **Free height – Perpendicular distance determined by placing the spring in between two straight plates when there is no load on it is called free height.**
B) **Working height – Perpendicular distance between the plates of the spring testing machine when specified static load is applied.**
C) **Solid height –Perpendicular distance between the plates of the spring testing machine when all coils come in contact without any space due to external load.**
D) **Pitch – Space between two adjoining active coil in Free State or under static load.**
E) **Nominal total deflection –The difference between the nominal free height and solid height of the spring.**
F) **Nominal free coil space –Nominal total defalcation of the spring divided by total no. of active coil.**
G) **Working load –Load acting on the spring under static condition**

Acceptable dimensions /accuracy in terms of numerals :-

1) **Bar diameter (AC/Non AC)**

A) **Axle box spring – Nominal dia. – 33.5mm.**

Permissible bar dia.- +1% - 0.8% of nominal bar dia.
There for maximum bar dia. = 33.5mm. +1% of 33.5mm.
= 33.5mm. +0.335mm. = 33.835mm.
There for minimum bar dia. = 33.5mm.-0.8% of nominal bar dia.
= 33.5mm.-0.335mm. = 33.165mm.

B) **Bolster spring – Nominal dia. - 42mm.**

Permissible bar dia.- +1% - 0.8% of nominal bar dia.
There for maximum bar dia. = 42mm. +1% of 42mm.
= 42mm. +0.42mm. = 42.42mm.
There for minimum bar dia. = 42mm. - 0.8% of nominal bar dia.
= 42mm. - 0.42mm. = 41.58mm.

2) **Tip thickness (AC/Non AC)**

Permissible tip thickness (AC) = $1/5^{th}$ of nominal bar dia.
= 42mm. » 5 = 8.4mm.
Permissible tip thickness (Non AC) = $1/5^{th}$ of nominal bar dia.
= 33.5mm. » 5 = 6.7mm.

3) **Grouping & color coding calculation (Non AC)**

A) **Axle box spring – Free height 360mm.Test load 2000 Kg.**
Max deflection 360mm. - 279mm. = 81mm.
Min. deflection 360mm. -295mm. = 65mm.
Men deflection = (81mm.+65mm.)/2 = 73mm.
Tolerance on free height = ±1.5% of nominal ht.

Therefore max. free ht. = 360mm.+1.5% of 360mm =360mm.+5.4 mm. = 365.4 mm.
Therefore min. free ht. = 360mm.-1.5% of 360mm =360mm.- 5.4 mm. = 354.6 mm.
Tolerance on deflection =± 3% of min deflection.
Therefore max. deflection = 73mm.+3% of 73mm =73mm.+2.19 mm. = 75.19 mm.
Therefore min. deflection = 73mm.-3% of 73mm =73mm.-2.19 mm. = 70.83 mm.
Therefore max. ht. of spring under test load 2000Kg. = max. free ht. - min deflection
=365.4mm.-70.83mm.=294.97mm.(295mm approx)
Therefore min. ht. of spring under test load 2000Kg. = min. free ht. - max deflection
=354.6mm.-75.19mm.=279.41mm.(279 mm approx)
Therefore spring range under test load 2000 Kg. will be 279mm to 295mm.
Similarly spring range for all other springs with different ht. and mean deflection under different test load can be calculated.

Pitch gap – (coil space)

A) Axle box spring (Non AC) – free height 360mm. coil dia. 33.5mm.
Defalcation range 279mm. to 295mm.

Total space among all active coil (off load free height)
= (free ht. - total active coil thickness)
= 360mm - 33.5mm. x 5.25 = 360mm. - 175.875mm. = 184.125mm.

Total max. Space among all active coil under test load / Tare weight.
= 279mm. - 175.875mm. = 103.125mm

Therefore max. space difference will be 184.125mm. - 103.125mm. = 81mm.

Since pitch gap in between two adjoining coil = max. space » total no of active coil
= 81mm. » 5.25 = 15.4 mm.

Total space among all active coil (under test load/tare weight)

Therefore min. space difference will be 295 mm. - 175.875 mm. = 119.125 mm.

Therefore total min. space under test load /tare weight will be
=184.125 mm.– 119.125mm. = 65 mm.

Therefore pitch gap = 65mm.» 5.25 = 12.4mm.

Hence max. and min. pitch gap in between two adjoining active coil at Test load 2000Kg. should be 15.4mm. and 12.4mm. respectively.

Similarly pitch gap for all other springs in between two adjoining active coil at different Test load and for different ht. can be calculated.