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Steam Locomotive Repair and Overhaul

Module LM6

Steam Locomotive Springs And Bogies

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Module BESTT LM6

Steam Locomotive Springs and Bogies

Aim

This unit will give learners an understanding of how Locomotive Springs and Bogies operate and how to examine for wear.

The learner will consider: -

- Springs
- Weighing of Locos
- Different types of Bogies and trucks
- Different types Radial Axles and boxes
- Examination and reporting

Learning Outcomes

LO1 springs

LO2 ‘Weighing’ a Locomotive, see also Module LM2

LO3 Bogies and trucks

LO4 Radial Axles and Boxes

LO5 Routine examination of springs

LO6 Routine examination of Bogies and trucks

INTRODUCTION

Springs and bogies might seem unlikely bedfellows in the world of steam locomotives but in fact they share a vital role in keeping fast-running powerful steam locomotives on the track steady and safe.

A good springing system ensures that all the wheels carry their allotted proportion of the overall weight, leaving the maximum allowable figure of weight to be carried on the driving wheels for adhesion purposes, without exceeding the maximum axle load dictated by the railway's civil engineer.

Bogies and carrying wheels are there to help guide the weight of the locomotive around curving track so that the driving wheels do not suffer from excessive flange wear as they lurch into bends which have less than perfect transitions from straight to curve, thereby damaging the rails and the coupled wheels.

STEAM LOCOMOTIVE SPRINGS

If a locomotive were not fitted with spring gear, tremendous shocks would be sustained by the wheels, axles, axle-boxes etc. owing to the great weight of the locomotive and the fact that there would be no "give" to allow for undulations in the track, points and crossings. Spring gear is normally made adjustable so that when the locomotive is new, and on subsequent occasions, adjustments can be carried out to ensure that the load on each wheel is as near as possible what the designer intended it to be. Thereafter when the locomotive is running over well -maintained track, the springs allow some vertical movement of the wheels and axles relative to the frame due to track irregularities without giving rise to sudden increases in load.

The spring-borne weight of a steam locomotive is the whole weight less the weight of the wheels, axles axle-boxes, coupling rods, eccentrics, and part of the weight of the springs and connecting rods. The weight of these items is un-sprung and kept to a minimum by the designer.

Fig 21 shows diagrammatically an equalised spring rigging and individual suspension for a typical 4-6-2 locomotive.

On Britain's railways the quality and standard of the maintenance of the track are such that variations in wheel load due to uneven track are not sufficient to call for departure from individual suspension arrangements. On less well-maintained track however the variations would be too pronounced so equalised or compensated spring rigging is fitted.

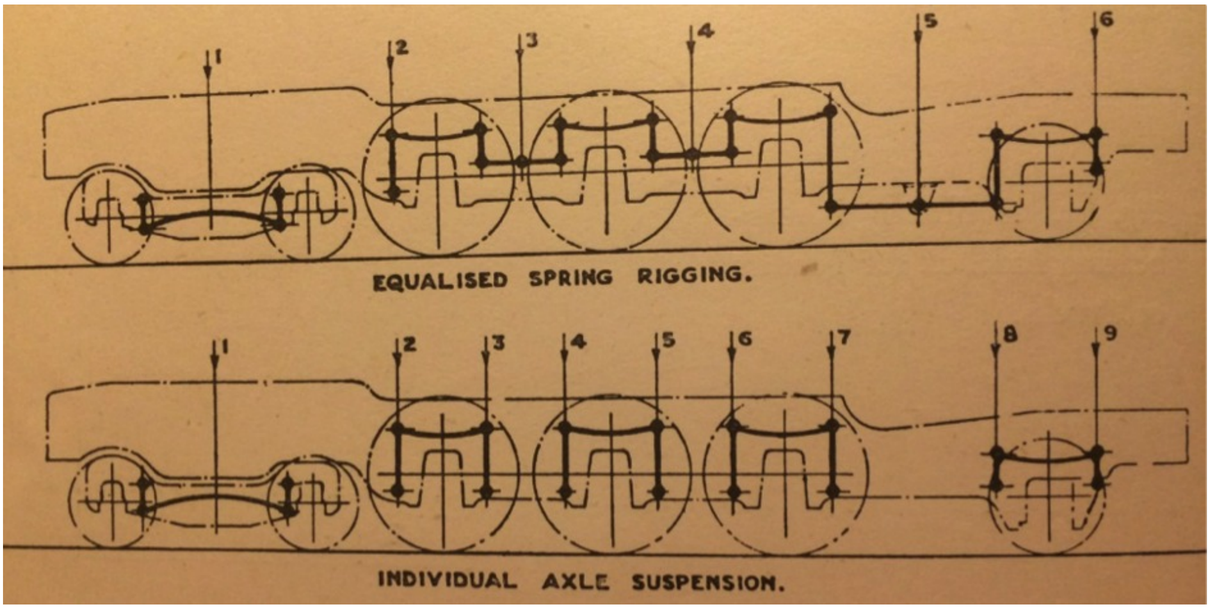

FIG 21

There are three main types of springs for locomotive suspension systems

Laminated, Helical and Volute

Laminated springs from a dismantled LMS 4F locomotive. Look carefully at the underside of the spring bottom left to see the groove and rib system of keeping the leaves in alignment without clamps discussed in the text.

Helical spring as we might find on a carriage suspension or modern locomotives. Steam locomotive helical springs used to be made from a square section bar called TIMMIS Springs.

Volute spring, which we might also often find on draw-gear or suspension on carriages and wagons. Unlike a leaf spring it has the ability to go solid once it has travelled fully.

Generally with steam locomotives we are dealing with laminated leaf springs and it is important to learn how and where to look for broken leaves within a spring assembly. Because the leaves are retained it is sometimes difficult to spot a breakage yet it can be critical. Breakages are caused by rough riding, overloading or dropped joints.

There is an interesting anecdote concerning the Isle of Man Steam Railway, which runs with a fleet of 2-4-0 Beyer Peacock passenger tank locomotives. They are fine looking machines with large driving wheels supported by an equalising beam, but the leading pony truck takes all the clout from bad track. Around the 1990s there was a Blacksmith employed in the Workshop whose sole job was making and repairing springs for that leading truck as the breakages came in regularly. At the Millennium the major part of the operating line was relayed with new heavier gauge modern track as part of a deal to find a route for the new sewer that was chosen to run beneath the railway. A much-improved ride resulted from this work and the spring breakages disappeared overnight!

Searching for broken spring leaves during locomotive inspections is not as easy as it might appear especially as is usually the case everything is covered in dirt and oil. This makes the case for regular and thorough cleaning of locomotives between and outside the frames.

The crack will generally show as a tiny vertical black line on one of the leaves, and is best viewed from under the engine with a lamp. Obviously if it is the top leaf that is broken then it becomes more self-evident but intermediate leaves are hard to spot when they are broken. Spring breakages are more likely to occur in frosty weather. The effect of a broken spring on the running of a locomotive depends on the location of the spring. If it is a middle-coupled wheel spring for example, a greater load will be placed on the adjacent springs, but the even keel of the engine is unlikely to be upset, and it will normally be possible to continue the journey at a slower pace until assistance can be obtained.

Similarly with coil springs it is very unlikely that the spring will break in more than one place so that the broken part will be retained. Again careful progress at reduced speed towards a place where help can be obtained should be possible.

Standard locomotive springs do not have adjusting screws, they have shims in pockets to lengthen or shorten the spring hanger.

NE & LNER tender springs are an interesting case as they have emergency supports attached to the frame of the vehicle which are held clear of the spring until top leaf breakage occurs. The danger with a broken spring on axleboxes that are supported outside the wheel is that the unloading of the end of an axle through spring breakage on one side could result in the wheel set tipping and the unloaded flange lifting clear of the rail causing a derailment. With axleboxes INSIDE the wheels such as on driving wheel axleboxes, the axle remains stable on the track even though the spring might be broken.

www.alamy.com - CTF67K

But the Learner must not under-estimate the difficulty of changing a spring under a locomotive or even making adjustments to the height the spring is set to. With up to twenty tons on each axle the adjusting nuts and lock nuts on the threaded spring hangers have to be adjusted with their full load present. It can help in the case of under slung springs to position a hydraulic jack under the spring buckle to as to take the weight off the hangers and so allow adjustment to take place more easily. Changing a spring can sometimes be helped by using an overhead crane with a hemp rope sling fed down through the spokes of a particular wheel, but of course the pull of the lift is not directly in line with what is wanted and great care must be exercised for safe working in the pit. Learners need to take part in this experience.

An idea of how tricky the operation of changing a spring is can be judged from watching the You Tube film below called "*5637 Spring Change*" It is Highly recommended viewing for the Learner!

https://www.youtube.com/watch?v=u4E9j1jzCeo

Once the locomotive is sitting on its new or repaired springs the overall height and the buffer height must be checked to make sure that the figures fall within those stipulated in MT276.

Adjusting spring hangers to get the right distribution of weight on the wheel can be very hard work, especially if the spring hanger needs to be tightened rather than slackened.

KELBUS SCALES in use on Green Arrow at NRM after changing a spring.

The process of manufacturing a leaf spring is shown well in

https://www.youtube.com/watch?v=k7MayvvgYLA

But the although the products are for automotive purposes the methods used are as for railway springs. One of the interesting and important processes is shown right at the end of the film, before painting. We call that compressive process after assembly “scragging” and it sets up the spring ready for use.

When the repaired or renewed spring is replaced within the locomotive it is important to check that the weight that the wheel is carrying is correct. In pre grouping days all locomotive repair works like Swindon, Doncaster and Ashford had special “weigh-houses” where individual weighing machines ran on a narrow gauge track in the bottom of a special inspection pit. The weighing machines were set at the correct wheel centres and the machine was adjusted under the flange of each wheel until the whole locomotive was suspended 0.5 mm off the rails. Each machine had a yard arm where the weight could be read off and appropriate adjustments made until the locomotive matched the figures in the weight diagram There is another old fashioned way of doing it using *Kelbus Scales* which are portable mechanical load cells which can be brought to the locomotive rather than having to take the locomotive to the weigh house.

Then there is a modern version of this kit by *Trainweigh* and others, which allows each wheel and axle’s weight to be measured on the move. *Trainweigh* have devised a weighing system that reads out as the train or locomotive drives over the sensor, which makes what was once a very laborious process very simple.

Watch

https://www.youtube.com/watch?v=Ub2j5drNJx0

Also there is an interesting article by PROCON showing *Flying Scotsman* was “weighed” using modern gear some years ago before the recent restoration.

http://www.proconeng.com/mainfiles/fscot.html

The necessity for this work has been touched on previously in Module 2.Axles and Axleboxes.

BOGIES AND TRUCKS

The first seventy years of railway locomotive history had large locomotives fitted with carrying (non-driven) wheels in order to keep the load on the remaining wheels within those dictated by the civil engineer. Often passenger express engines were fitted with a four-wheel bogie at the front and sometimes a trailing "truck" or two-wheeled bogie at the rear.

As most of the running of these express passenger train engines was forwards then this remedy was adequate. As a locomotive so fitted launched itself into a bend at high speed the leading bogie which had lateral movement controlled by "side control springs" to manage lateral movement exerted some lateral force on the front of the locomotive frame to get the front end to follow the curvature in the track rather that leaving it to the flanges on the driving wheels to force the locomotive into the bend. The bogie wheels shared the job of lateral persuasion, but it was much easier and cheaper to have to reprofile small bogie wheels than the larger driving wheels when flanges got excessively worn carrying out this task. Also this method assisted the civil engineer in sharing the lateral forces on the track formation over several wheel sets.

If we digress for a moment and look at the layout of William Stroudley's *Gladstone* in FIG 1 below we are looking at a locomotive designed when the aesthetic correctness of the look of the steam locomotive held sway over the physical form the locomotive was to take. (Much in the same way that Patrick Stirling would not allow his famous and beautiful Great Northern Singles to be equipped with a dome in the middle of the boiler to collect dry steam even though the case for the technical superiority of dome fitted locomotives had been well proven!)

Stroudley on the London Brighton and South Coast Railway, didn't want his locomotives to be encumbered in their appearance by having carrying wheels at the front, yet he knew that the flanges on the leading drivers would have to take all the side loads as the locomotive negotiated a bend. This put the driving wheel flanges under unusually high side loads and in order to mitigate that potential source of wear between flange and rail, Stroudley ran copper pipes from the cylinder drain cocks to the leading driving wheel flanges. This meant that slightly oily water was being directed onto the leading flange. What this did for the locomotive's ability to grip the rail is not mentioned. You can just see the loop of copper pipe behind the right hand leading lifeguard in the photograph.

FIG 1

But there was something much more subtle going on, that took a while for the penny to drop with design engineers in terms of how the bogie carried the weight of the front of the locomotive. Look at the image of a model bogie 19th C locomotive FIG 2, showing how the weight of the front of the boiler and smokebox as well as the cylinders is carried on the front bogie. As the locomotive tries to go on straight on, the curved track forces the bogie wheel flanges across and the front of the locomotive has no choice but to move with it.

Some improvement was introduced by fitting a sliding block with side control springs, which gave the front bogie more time and opportunity to heave the front of the locomotive, round the bend and spread the load on the wheel flanges. This is shown in FIG 3

As the locomotive goes into the bend there is a tendency to roll towards the outside of the bend and of course the nightmare is that the outside wheels become overloaded and the inside ones lift clear of the track. Even from the early days the civil engineers tilted the track over towards the inside of the bend (called “cant”) in the manner of a “wall of death” fairground ride, or Velodrome track, but there was a limit to what could be done as it was possible that trains might have to come to rest on this inclined track and still be safe. Generally this inclination was confined to about 8 degrees, and it did indeed help to throw the centre of gravity of the locomotive slightly towards the centre of a bend, but it was not sufficient on its own to solve the problem.

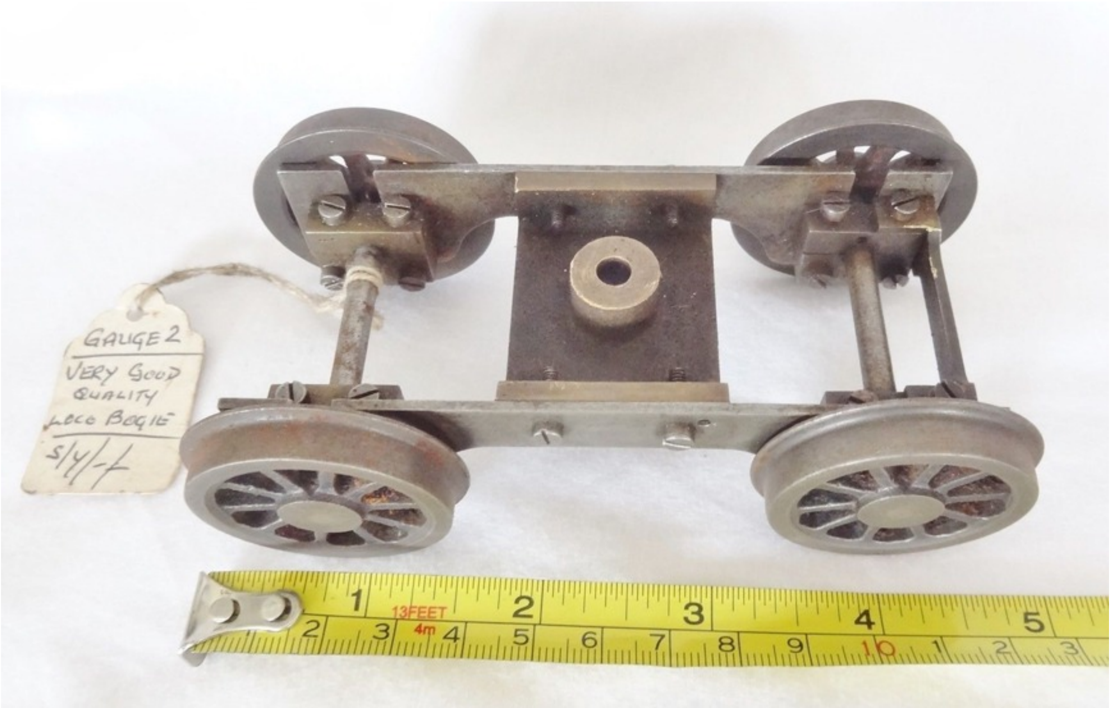

FIG 2

FIG 3

Something much more radical was required and the as time went on we find several exciting developments.

As early as the 1860s the Manchester firm Beyer Peacock's design of Passenger Tank engine with a pony truck or two-wheel bogie called a Bissel Truck beneath the cylinders employed a set of shallow vee type supports between the frames. The way this worked is that as the pony truck ran into the bend it forced the front side of the loco (on the outside of the bend) upwards whilst simultaneously lowered the opposite side. The act of lifting the locomotive to lean it into the bend meant that there was a strong self-centring action which brought the locomotive back to equilibrium as soon as the bend eased. FIG 4 shows the shallow vee section and guides on top of the right hand stripped bogie frame of one of the Isle of Man Beyer Peacocks with the familiar horn guides of the axlebox in the bottom right hand corner

FIG 4

Several years later the development of the SWING LINK bogie suspension completely alters the attitude of the front of the locomotive as it encounters the bend. Look at diagram FIG 5 and see the difference between the solid outline when the vehicle is on straight level track, and the dotted outline as the bogie is forced to the left of the pivot on a left-hand bend. The off-vertical links which carry the weight cause the block in which the front of the locomotive is supported to tilt and throw the weight of the front of the machine towards the inside of the bend.

The diagram is turned into reality in FIG 5 showing the bogie for the newly created "*Brighton Atlantic*" replica currently being constructed from scratch at the Bluebell Railway in Sussex.

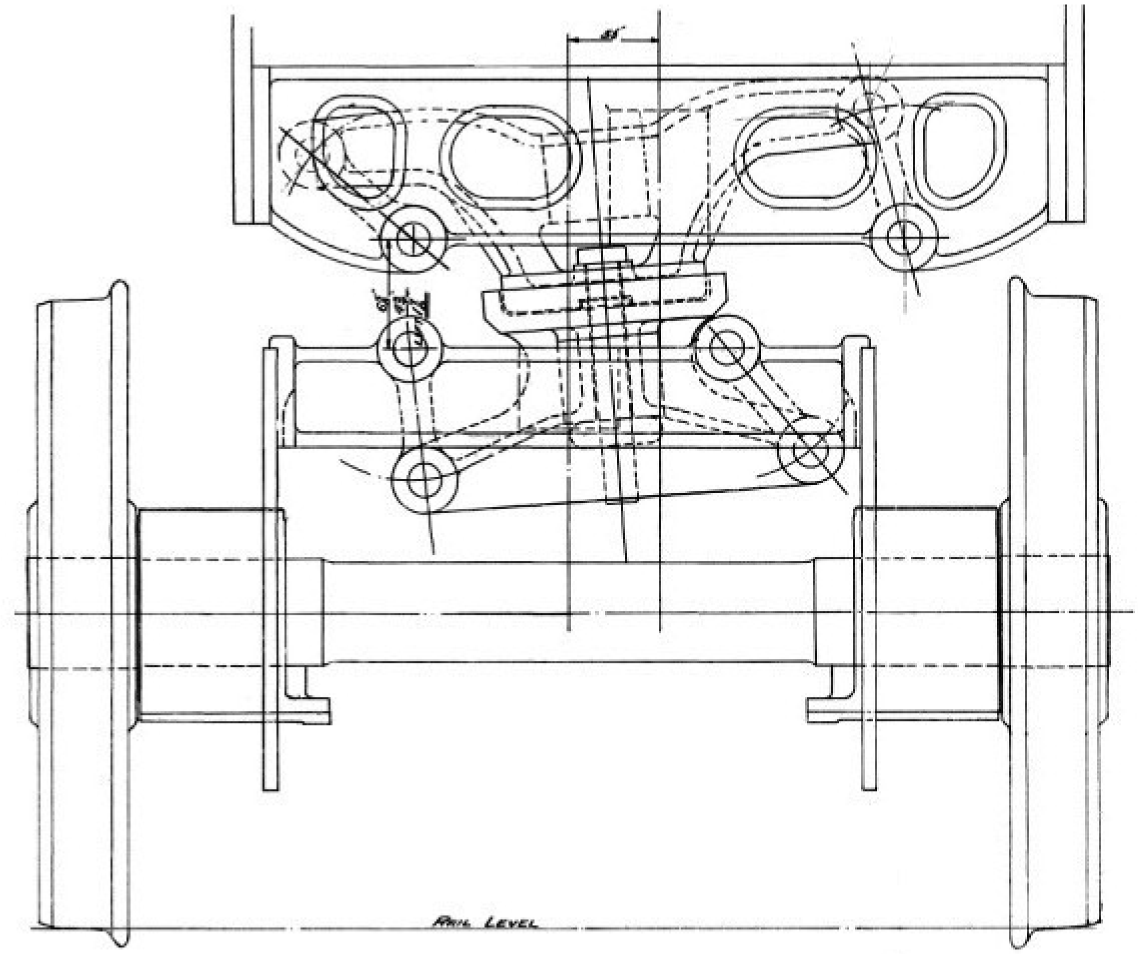

FIG 4

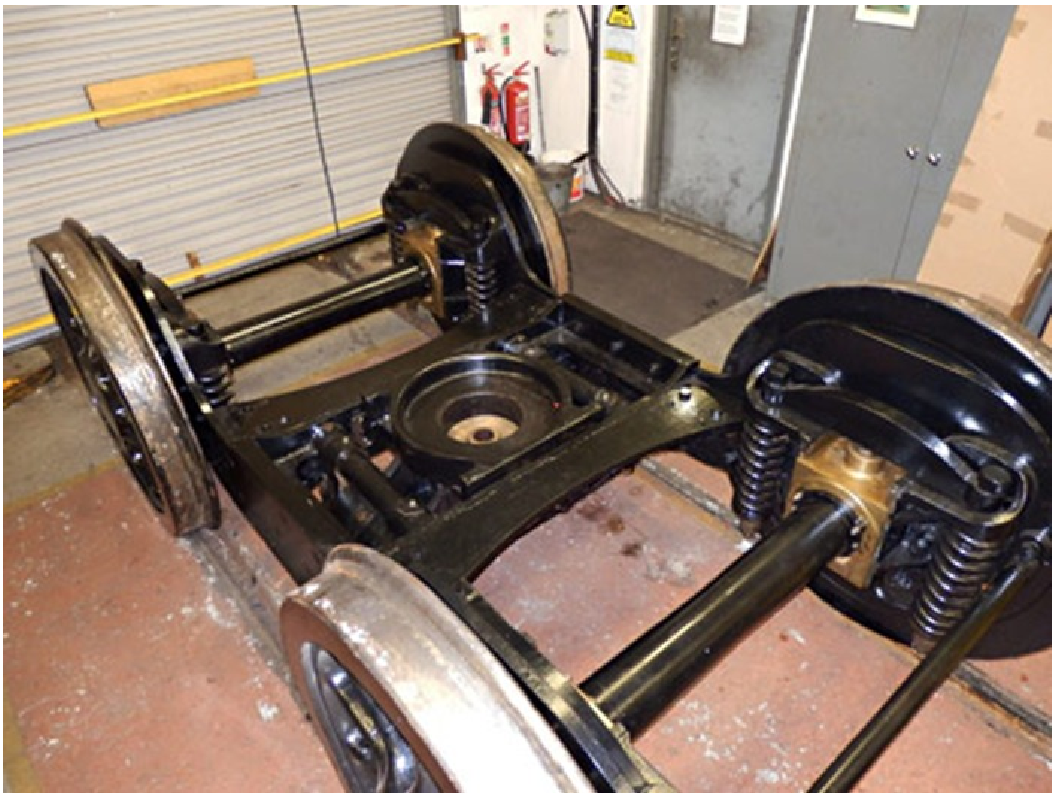

FIG 5


FIG 6

But the swing link bogie or truck design still suffers from a major drawback.

All the weight of the front of the locomotive is bearing down on the centre of the bogie frame. This means that the centre casting has to carry all the weight and transfer it to the side plate bogie frames so that eventually the carried weight is transferred through the springs to the wheels.

It was George Jackson Churchward Engineer of the Great Western Railway in 1904 onwards who realised that the French Locomotive Engineer De Glehn's design of bogies and trucks was much more what was needed than current practice. Churchward's bogie design for his new locomotives allowed the weight of the front of the locomotive not to be placed on the central pivot and thence out to the bogie frames, but to be carried downwards either side of the main frames straight onto the top of the bogie frames directly from the locomotives own frames. This can be seen in FIG7 on Castle Class 4-6-0 *Earl Bathurst* where a bracket from the main frames supports a bronze cup, which slides as the bogie moves. The lubrication of this system was important but it can be seen that the weight of the heavy front end is carried directly to the bogie without the weighty and cumbersome bogie centre castings.

Both Churchward and Nigel Gresley were steam locomotive designers who believed that lessons from around the world could be learned to improve their own locomotive designs, and it is very significant that when William Stanier came to the LMS from Swindon to be CME he brought with him the GWR front end design which we can still see in the Coronation Pacific of *Duchess* Class

FIG 7

This design feature also illustrated in Fig 8 which is the leading pony truck design proposed for the new LNER 2-8-2 P2 Class currently being built at Darlington based on the Gresley design for the LNER. This locomotive has side control springing and pads to carry the load up into the locomotive frame

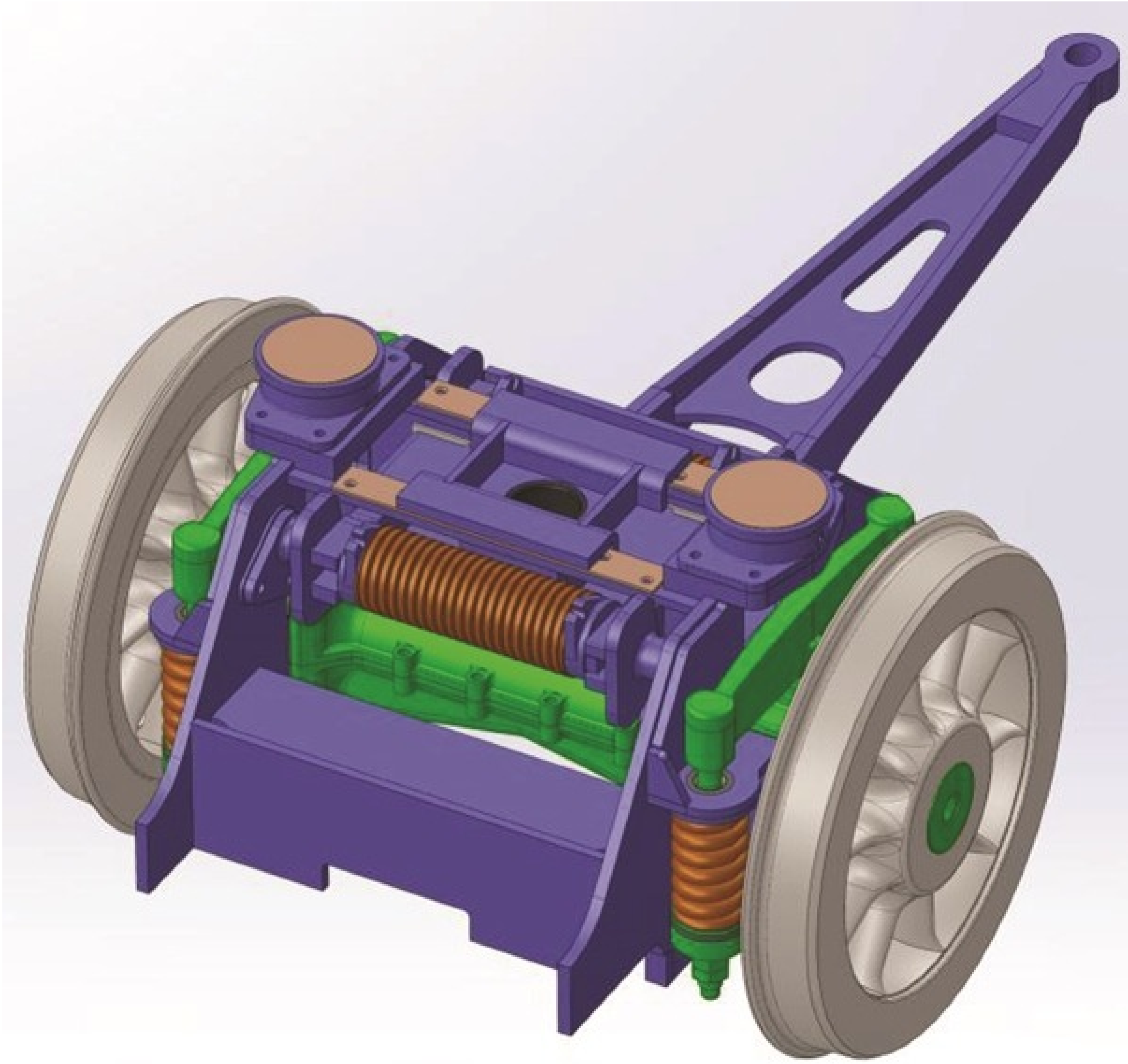

FIG 8

RADIAL AXLES & AXLEBOXES

In earlier modules we discussed the importance of the four-wheel bogie system allowing for minimal misalignment of the axle as the train travels round a curve. The scrubbing that results between wheel and rail with misaligned axles has been one of the great challenges set to railway vehicle designers over the last two hundred years and we are still struggling with the consequences of non-radially aligned axles with the remnants of the four-wheel Pacer fleet of Class 143 vehicles which at last everyone seems to acknowledge, will have to be superseded by more track friendly vehicles. Gauge corner cracking of rails that led to such problems as the accident at Hitchin in 200? Is now more fully understood and steps have been taken to minimise the stresses at the wheel rail interface by allowing axles to align themselves radially and avoid mismatch.

A pony truck such as that shown in FIG 8 above fits the bill perfectly in that it allows the axle to move sideways on a curve and yet remain truly radial to the curve. However the conventional design of steam locomotive is not suited to placing a pony truck pivot at the rear of the locomotive chassis.

Design engineers have applied themselves to the issue of introducing radial axles throughout locomotive history and the learner could usefully research Cleminson Carriages and Indian Matteran Locomotives to learn more about how important this topic has been to the safe running of railway vehicles.

However the purpose behind this module is to make the learner be familiar with the more common types of radial axles they are likely to come across in the UK.

- Radial Axles can be found on LNER 2-6-2 & 4-6-2 Locomotives based on the Cartazzi principle.
- Radial axles were used on long wheelbase 2-4-2 tank engines with the Lancashire & Yorkshire Railway, as well as the GWR 2-4-2 0-6-2 Welsh Valleys tank locomotives and others based on the curved common axle-box principle. The so-called Adams “Radial” 2-4-2 Tank engine also incorporated a curved continuous axle-box running under the bunker.
- Radial axles can be found in the Class 40 English Electric 1-co-co-1 which are based on the Swing Link principle

  Taking these in turn:
- The Cartazzi axlebox is not the easiest concept to understand because of the very different angles involved. See frame layout plan in FIG 1

Its great advantage comes from the ability of the axle to behave as though it is held in a self-centring pony truck, where the actual pivot for such a pony truck does not exist. The siting of such a pivot were it real, would come in the centre of the locomotive ashpan!

Wikipedia suggests

“A **Cartazzi axle** is a design of leading or trailing wheel support[1][2][3] used worldwide.[4][5][6][7][8] The design was used extensively on the former LNER's Pacific steam locomotives and named after its inventor F.I. Cartazzi,[9] formerly of the Great Northern Railway. It should not be confused with a pony truck, as it does not pivot at all.[8] The axle does, however, have sideways play built in to accommodate tight curves. Cartazzi's design causes the weight of the locomotive to exert a self-centring action on the trailing wheels.[10]

The Cartazzi design was also sometimes applied to driving wheel axles on longer wheelbase locomotives.[11]"

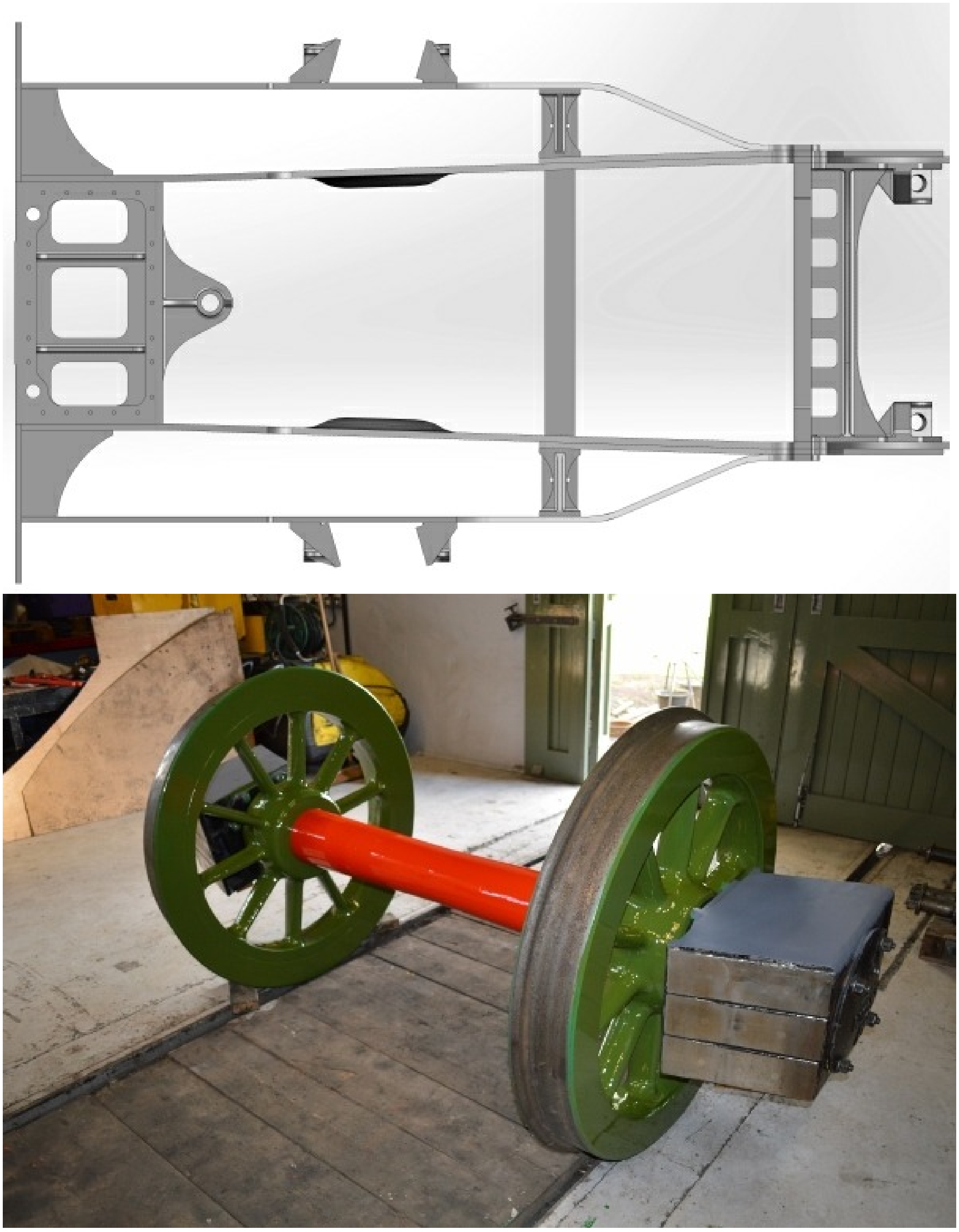

FIG 2 A1 Locomotive Trust Cartazzi wheel set & Axleboxes

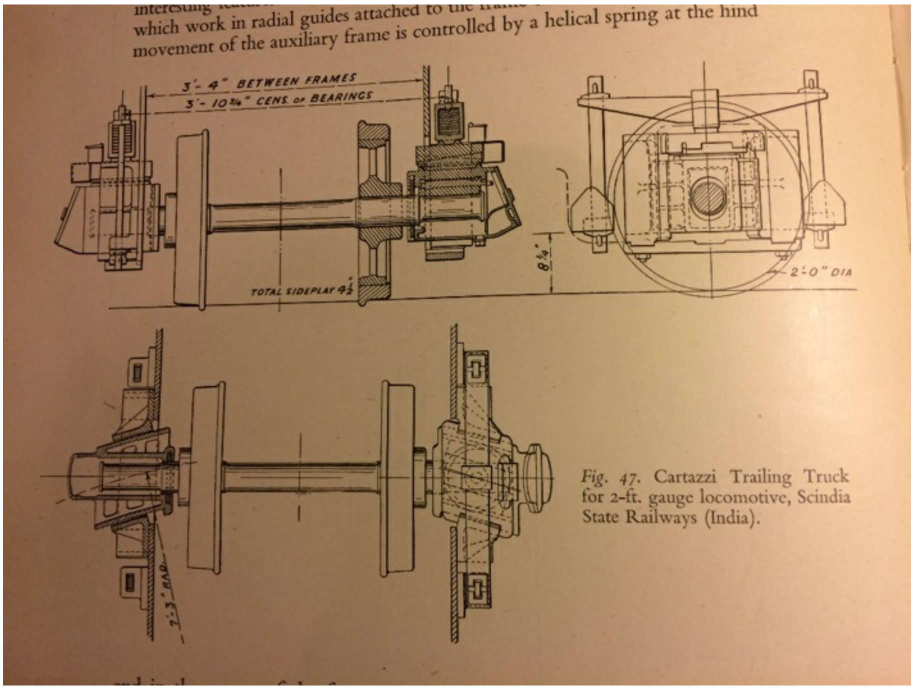

FIG 3 Drawing of Narrow Gauge Cartazzi

In addition to allowing the sideways movement of the axle and boxes in a near- radial fashion, there are bronze ramps between the spring buckle and the top of the axlebox itself. Those force the spring upwards as the axlebox displaces itself sideways. This helps the locomotive stay in a stable condition on the bend and also provides a strong self-centring motion for the trailing wheel set as the locomotive emerges from the bend.

The second type of radial axlebox is based on the idea shown below in FIG 4

The axleboxes are situated in a curved slide, which encourages sideways movement and keeps the axle correctly radial to the curve.

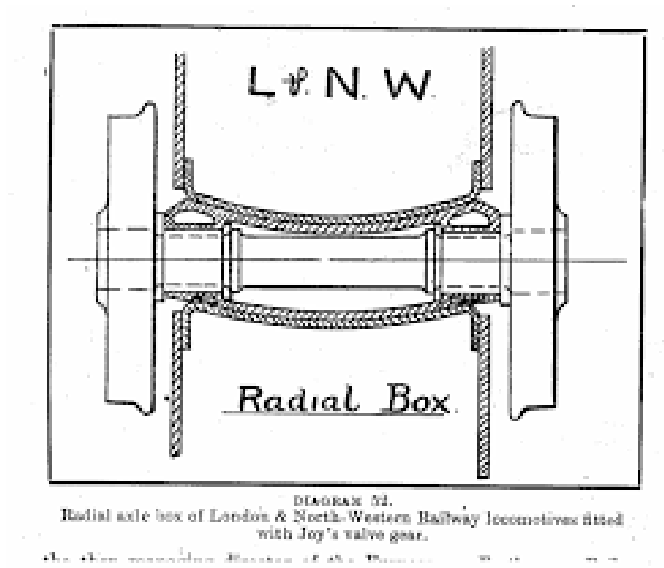

FIG 4 Plan view typical radial axle-box

This type of axlebox was effective for presenting the axle in a radial fashion to the track but it did not offer the rise and fall feature discussed above. One other problem was that this device which relied on being kept properly lubricated to work correctly was in an inaccessible and often very much neglected place on the locomotive. That is right under the coalbunker. Corrosion and water ingress was a perennial problem.

A good example of this mechanism is available at the K&WVR in their 0-6-2 Taff Vale Railway Tank engine

The third type of radial axlebox, which is really outside the scope of this series of modules but is, nevertheless of interest is the swing link axle-box we find on the leading and trailing axles of the Class 40 and 44 Diesel Electric Locomotives built by English Electric.

Their all up weight was such that the decision was made to put carrying (non-driven) wheels at the outer ends of the locomotive bogies but clearly these had to be radial in view of the locomotives great length.

FIG 5 Class 40 Diesel Electric Locomotive showing leading undriven wheel set

Although it appears at first that the leading and trailing axles apparently have no support, in fact the leading axle is supported on swing links (pivoted behind the front buffer beam) rather in the same way that the Gresley LNER pony truck system works but this time the links are horizontal rather than vertical. As these locomotives are common in preservation the Learner should produce a sketch as part of the assessment of this module describing how this wheel set manages to articulate and remain radial whilst still carrying a useful proportion of the locomotives weight. This wheel set steers each bogie into the bends in the same way that the other systems described above.

Before we leave the topic of radial axles there is one more fascinating topic, which all Learners should understand if they are to really grasp the subject fully. Again this example is outside the scope of this module but is relevant to its conclusions.

The Class 66 Freight locomotive is a heavy powerful machine, which runs on two six-wheel powered bogies. In the early days there was concern that the flange wear and track wear might be higher than was acceptable to the UK so the later batch of locomotives were built with automatic steering leading and intermediate axles. This involves some dramatic engineering between the top of the bogie and the body of the locomotive. As the leading bogie launches into the bend so the pivoting of the bogie steers the leading and intermediate wheel sets to remain radial to the track. The trailing axle of each bogie is so near the neutral point in the centre that there is no need for those to be steered. The end result has been a dramatic reduction in flange wear.

FIG 6 Class 66 locomotive

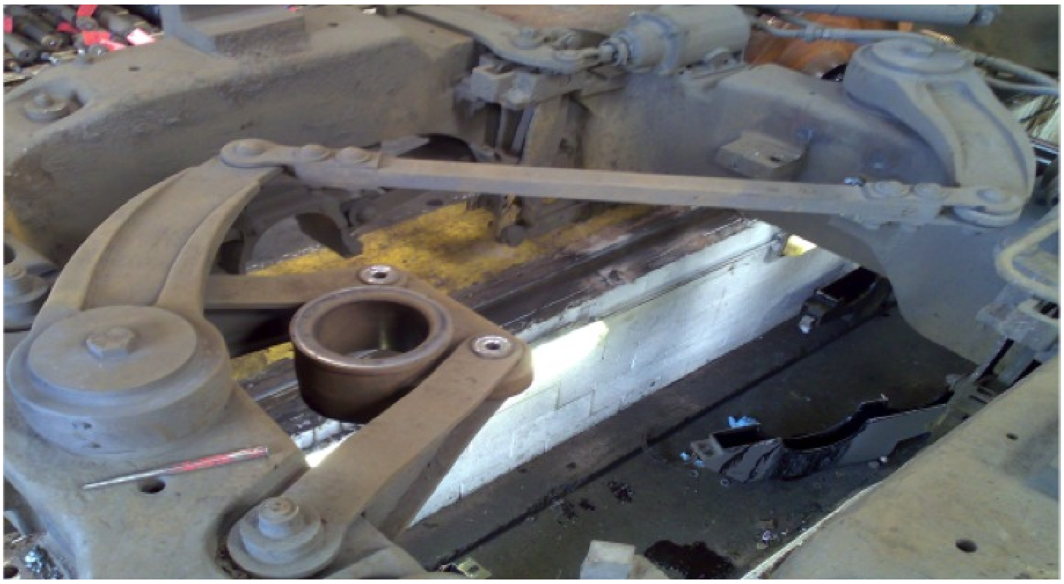

FIG 7 How the Class 66 leading and intermediate axles steer

LO1: Springs - General

1. Un-sprung weight
2. Types of springs
3. Types of springs
4. Equalised spring rigging
5. Broken Spring
6. Outboard axlebox
7. Fitting a New Spring

LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
LO1 1	Un-sprung weight	What is meant by the term 'un-sprung weight?	Classroom	
LO1 2	Equalised spring rigging	Draw a diagram of 'equalised spring rigging'	Classroom	
LO1 3	Types of Springs	Name the three common types of springs you are likely to encounter on a steam locomotive suspension	Classroom	
LO1 4	Types of Springs	Sketch the three springs and in a typical application	Classroom	
LO1 5	Broken Spring	Describe how you may detect a broken spring	Classroom	
LO1 6	Broken Spring on outboard axle box	What are the dangers of a broken spring on an outboard axlebox?	Classroom	
LO1 7	New Spring	After fitting a new spring what checks should be carried out?	Classroom	

LO2: **Weighing a Locomotive**

To be used in conjunction with module 2

1. ‘Weighing’
2. Methods
3. Adjusting
4. Manufacture

LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
LO2 1	Weighing	After changing a spring why is it important to ‘weigh’ the locomotive	Classroom	
LO2 2	Weighing methods	Describe with diagrams 3 methods of ‘weighing a loco’	Classroom	
LO2 3	Adjusting	How do you adjust the load on each wheel?	Classroom	
LO2 4	Manufacture	Briefly describe a method of manufacturing a replacement laminated spring	Classroom	

LO3: Bogies & Trucks

1. Why use Bogies and trucks?
2. Negotiating a curve
3. Cant
4. Bissel truck
5. Swing Link Suspension
6. Load transference to frames

LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
LO3 1	Bogies	Why are bogies and trucks used?	Classroom	
LO3 2	Negotiating curved track	How does a front bogie assist the locomotive in going round a curve in the track?	Classroom	
LO3 3	Cant	What purpose does ‘Cant’ on a track serve?	Classroom	
LO3 4	Bissel truck	Explain the action of a ‘Bissel Truck’ on a Locomotive negotiating a curve	Classroom	
LO3 5	Swing Link suspension	Explain the action of Swing Link suspension on a Locomotive negotiating a curve	Classroom	
LO3 6	Load carried on frames	Draw a diagram of a front bogie where the load is imparted to the frames of the loco and not the central pivot	Classroom	

LO4: Radial Axles and boxes

1. Radial alignment
2. Cartazzi Axle
3. Radial Axle box
4. Swing Link Axle box

LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
LO4 1	Radial Alignment	Why is it an advantage to have axles radially aligned to a curve?	Classroom	
LO4 2	Cartazzi axle	Describe with the aid of diagrams the Cartazzi axle arrangement	Classroom	
LO4 3	Radial Axle Box	Draw an annotated diagram of a Radial axlebox	Classroom	
LO4 4	Swing Link Axle box	Describe with the aid of diagrams how a swing link axle box functions	Classroom	

LO5: **Routine Examination - springs**

Refer to MT 276 for limits of wear

1. Laminated Springs
2. Coil Springs
3. Spring Hangers
4. Bogie side control springs

LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
LO5 1	Laminated Springs	Examine all springs for broken leaves or shifted plates	Classroom	
LO5 2	Coil Springs	Examine for breaks in the coils, tell tale rust signs	Workshop	
LO5 3	Spring Hangers and seats	Check security of spring hangers and seats, and securing fastenings	Workshop	
LO5 4	Bogie side control	Check bogie side control springs	Workshop	

LO6: **Routine Examination Bogies and trucks**

Refer to MT 276 for limits of wear

1. Cracking of Frames
2. Bogie Centre bolts
3. Bogie spherical bearings
4. Bolster Pads
5. Truck Centre Pins
6. Pony Truck
7. Main Beam
8. Radial Axle Boxes
9. Cartazzi trucks

LO	Objectives	Assessment Criteria	Delivery	Date achieved and Supervisors signature
LO6 1	Cracking of frames	Examine frames of Bogies & Trucks for cracking	Workshop	
LO6 2	Centre Bolts	Check for security of centre bolt and the security of safety fastenings	Workshop	
LO6 3	Bogie Spherical bearings	Check for security, missing bolts, loose bolts and fractures	Workshop	
LO6 4	Bolster pads	Check for cracking on bolster pads and truck radial arms	Workshop	
LO6 5	Truck centre pins	Check pins for security along with split pins or cotters	Workshop	
LO6 6	Pony Truck	Check for loose or missing bolts, main beam front pin and cotters and rear compensating beam end nuts	Workshop	
LO6 7	Main Beam safety clips	Check main beam rear end safety clips for security	Workshop	
LO6 8	Radial axle boxes	Check radial axlebox horn guides and that the laminated springs are not displaced	Workshop	
LO6 9	Cartazzi truck	Ensure the Cartazzi axle box horn liners are in the correct position	Workshop	

On completion of the module the trainee should be able to use correctly and safely the following equipment:

- Measuring instruments
- Hand Tools

Assessment

Learners could demonstrate competence in this unit by:

- Documental evidence
- Photographic evidence
- Witness statements e.g. written or verbal statement from a competent person stating that they have completed tasks satisfactorily.
- Underpinning knowledge questions e.g. written questions, multi choice answer sheets, on-line tests, and assignments.
- Practical training tasks

BESTT Locomotive repair and overhaul - Module LM6 – Springs and Bogies

Assessment Record for: **Training Centre:** **Year:**

LO1	**1**	**2**	**3**	**4**	**5**	**6**	**7**			
Supervisor Initials and date										
LO2	**1**	**2**	**3**	**4**						
Supervisor Initials and date										
LO3	**1**	**2**	**3**	**4**	**5**	6				
Supervisor Initials and date										
LO4	1	2	3	4						
Supervisor Initials and date										
LO5	1	2	3	4						
Supervisor Initials and date										
LO6	1	2	3	4	5	6	7	8	9	
Supervisor Initials and date										

Witness Statement: The trainee has completed the Learning outcomes to a satisfactory standard

Supervisor signature: **Print Name:** **Date:**

Verified by BESTT Assessor **Name:** **Assess**