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## **Bogie Test Stand NBT**

**Technical Description for Evaluation purpose**

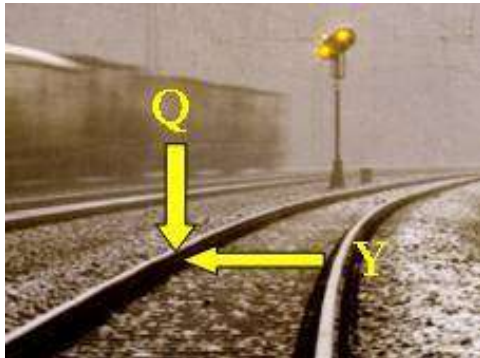
## 1 Nencki Bogie Test Stand Evaluation

### 1.1 Why a Bogie Test Stand?

#### Increasing demand for bogie testing

Higher axle loads, reduction of noise, less wearing on the wheel/rail interface, reduction of life cycle costs and specially the increasing conditions on bogies for high-speed trains are demanding for an instruments which allow to test, to simulate the bogie's characteristics in the workshop. Therefore rolling stock manufacturer and maintenance workshops are investing more and more into bogie testing facilities.

#### What influences the derailing of a train?



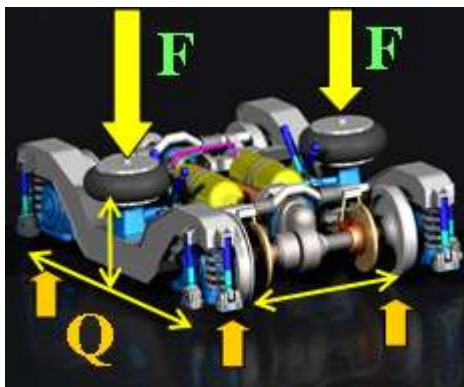
There are two important factors which influence the derailing index. On one side it is the lateral force ( $Y$ ) which is specially increasing in curves or in case of strong side winds. On the other side it is the wheel load ( $Q$ ) which should be strong enough in order to resist the  $Y$ .

If for example one primary spring is too soft and the other too hard this might cause different load on the wheels and increasing derailing danger.

#### The purpose of a bogie test stand

The bogie test stand allows simulating the load of a vehicle or locomotive body in order to control the wheel load and other important functions on a bogie after assembling or before disassembling in the workshop

### 1.2 Short description of the functions of a bogie test stand



After positioning the bogie on the test stand, two hydraulic cylinders apply a load ( $F$ ) onto the application points where normally the vehicle is fixed. The load is computer controlled.

Now is determined how the simulated load is distributed to each single wheel ( $Q$ ).

Depending onto the available technology on the test stand, it is possible to control the axle distance, axle parallelism, suspension, unbalance run-out) and diameter of wheels etc. fully automatic.



# Technical description Bogie Test Stand

After the test all values are stored in the PC and can be printed as a protocol.

If several types of bogies and parameters must be tested, then it is necessary to use a machine which can be easily adjusted for other bogie heights, gauges, from 2 to 3 axles etc.

## The bogie test stand is the heart of the bogie maintenance

The bogie test stand allows a quick test of the conditions of a bogie before the maintenance starts. The result is a base for the planning of the process. After maintaining, exchanging components and assembling, the bogie and its functions can be examined entirely. This is the only way to be sure that components have been assembled correctly.

It is much faster and economic to do modifications after realizing an error on the bogie stand than disassembling the cabin of a vehicle after realizing the error after wheel weighing.

The test result which is the quality and function report is automatically stored and can be recalled at any time in case of an incident.

### 1.3 Which type bogie test stand should be purchased?

Each application depends on the type of bogies which should be tested, on the regulations and standards of the rolling stock and bogie manufacturer, the national and international rules of the railway organisations and the railway company itself.

Nencki has developed a system which allows manufacturing a tailor-made customer and bogie specific machine.

### 1.4 Important criteria for the evaluation of a bogie test stand

Criteria	Our requirements
How many axles do our bogies have? 2 or/and 3	
Which size do our bogie(s) have?	See below
Which test and control features do we need? (see chapter test functions)	
Which test and control features could be required in the future because of new regulation or new rolling stock?	
What do we expect regarding after sales support and spare parts supply?	
Where the bogie test stand should be situated?	
Which standards are relevant for the tests?	



# Technical description Bogie Test Stand

## **2 Range of Nencki bogie test stands**

Nencki offers the below mentioned types of machines.

### **2.1 *Nencki Bogie Press (NBP)***

The press can apply with 2 load cylinders a force onto the bogie for assembly and disassembly purpose. It is not possible to test the wheel load. This machine is not described in this document.

### **2.2 *Nencki Bogie Test Stand BASIC (NBT Basic)***

The machine can test the wheel load and a some other functions. But it can not test any parameter of the axle geometry. It is also not possible for any upgrading later on.

### **2.3 *Nencki Bogie Test Stand COACH (NBT COACH)***

The machine can test wheel loads, the axle geometry and many other functions. It is the optimal solution for manufacturer and operators of EMU's, high-speed bogies, metro and tram bogies. This type of machine is only suitable for 2 axles.

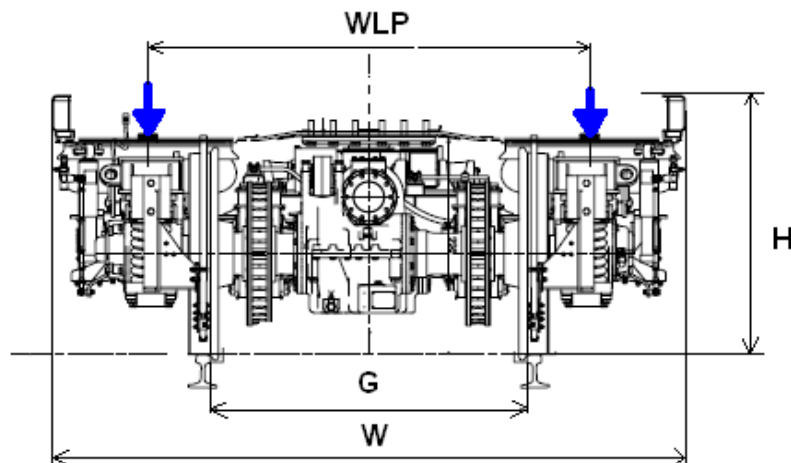
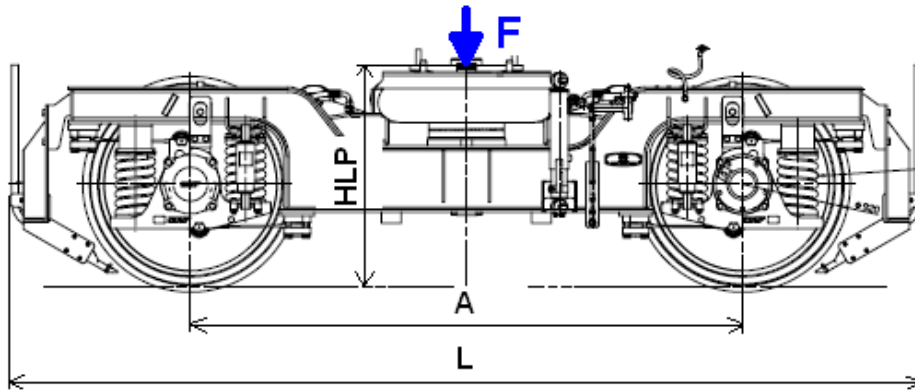
### **2.4 *Nencki Bogie Test Stand LOCO (NBT LOCO)***

This machine can test wheel load, axle geometry and many other functions on 2 and 3 axle bogies of locomotives and EMU's etc.

## 2.5 Test and control functions of the Nencki Bogie Test Stands

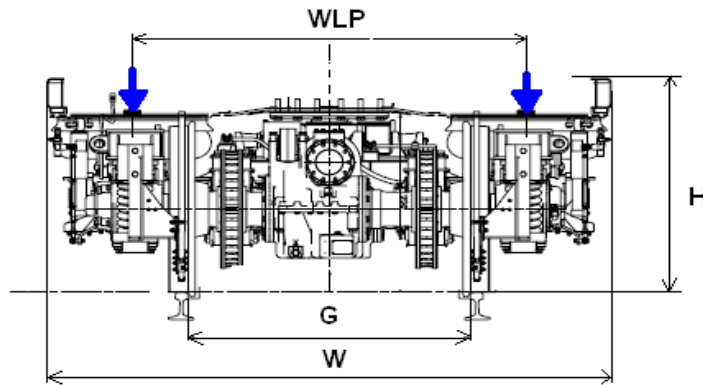
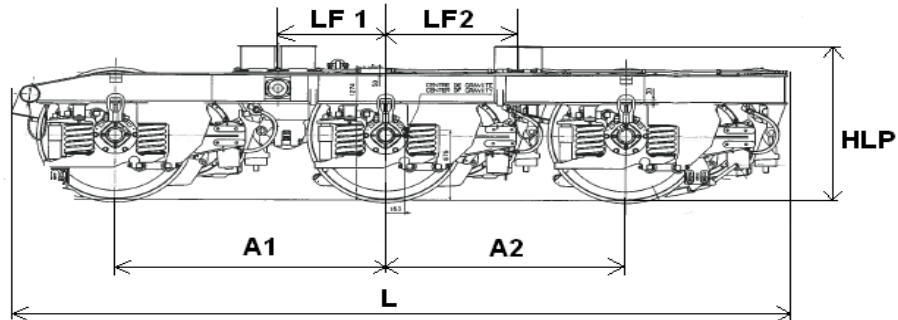
Basic	Loco	COACH	Test feature	Value	
			Load applied, synchronous or independent	kN or mm	
			Wheel load on each wheel distributed	kN	
			Wheel load compared between wheel, axles, average	%	
			Height of points on the bogie frame from T.O.R	mm	
			Height of secondary suspension from T.O.R.	mm	
			Wheel diameter manually measured	mm	
			Stiffness of each primary suspension (wheel load and suspension stroke under diff.loads)	kN/mm	
			Calculation of shim plates for primary suspension	mm	
			Calculation of shim plates for secondary suspension	mm	
			Secondary air suspension leakage test	bar /pa	
			Air brake system leakage test	bar / pa	
			Axle impedance measuring	Ohm	
			Wheel shoulder distance	mm	
---			Axle distance (left and right side)	mm	
---			Axle parallelism (calculated from left and right distance)	mm	
---	---		Axle angle	Mrad	
---	---		Axle distance diagonal	mm	
---			Application of side force	kN or mm	
---			Movement of wheels in Y direction under vertical load or under side force.	mm	
---			Wheel diameter automatic	mm	
---			Wheel run-out in X direction	mm	
---			Wheel run-out in Y direction	mm	
---			Wheel profile		
---			Axle sensor function test		
---	---		Changing of the wheel load under the condition that one	kN	
---	---		Measuring of tilting angles	Mrad	
---	---		Testing wheel steering mechanism (radial bogie,	Mrad, mm	

## 2.6 Checklist: Bogie dimensions and Load application points (2 axle bogies)



	Dimension	Minimum	Maximum
L	Bogie over-all length		
H	Bogie over- all height		
W	Bogie over-all width		
A	Axle distance		
G	Gauge		
WLP	Lateral distance of loading points		
HLP	Height of loading point from T.O.R.		
	Bogie weight		
	Wheel diameter		
	Height of wheel flange		

## 2.7 Checklist: Bogie dimensions and Load application points (3 axle bogies)

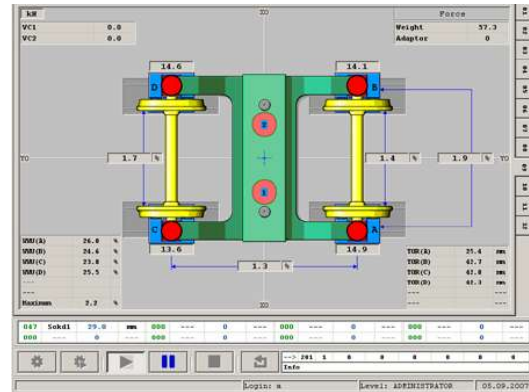
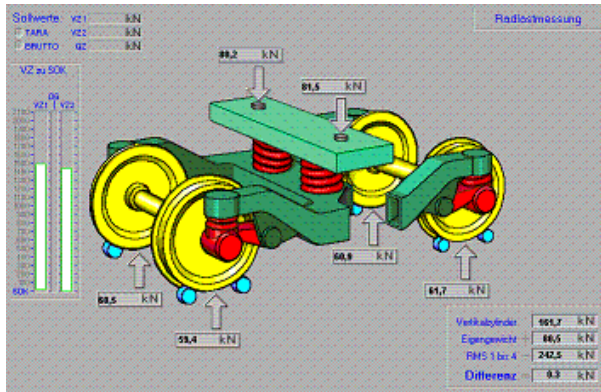


	Dimension	Minimum	Maximum
L	Bogie over-all length		
H	Bogie over-all height		
W	Bogie over-all width		
A1	Axle distance 1		
A2	Axle distance 2		
LF1	Loading points out of the centre, front		
LF2	Loading points out of the centre, back		
G	Gauge		
WLP	Lateral distance of loading points		
HLP	Height of loading point from T.O.R		
	No. of loading points	2	
	Bogie weight		
	Wheel diameter		
	Height of wheel flange		



## 3 Test functions

### 3.1 Wheel load measuring



The wheel load is the most important value on the bogie. The load of the vehicle should be distributed equal to every single wheel. Unequal wheel load has very bad influence on the derailing index, of running characteristic, wearing on the interface wheel/rail etc.

After application of the test load with the vertical load cylinders, the system records online how the load is distributed to every single wheel.

#### 3.1.1 Standards for loads and tolerances:

The designer/manufacturer of the bogie defines the range of the test loads. The values should be written in the bogie's maintenance manual. Further standards are made by organizations such as UIC, by the railway authority of a state or the operator of the railway/metro himself.

Standards are not given by the manufacturer of the bogie test stand.

The net weight of the bogie is recorded / calculated as well.

### 3.2 Compression stroke of the bogie under different loads

On the Nencki bogie test stands each vertical load cylinder is equipped with linear measuring scale which allows the online recording of the compression stroke on the left and right side of the bogie.

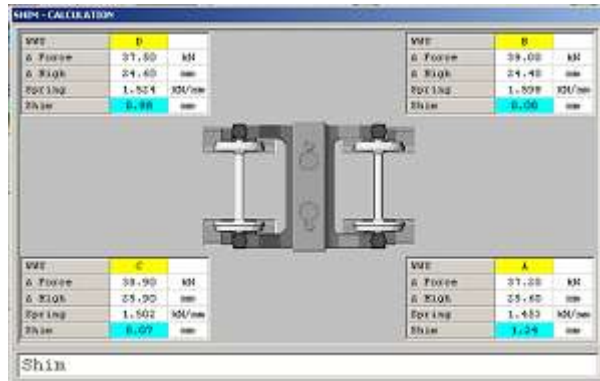


### 3.3 Calculation of shim plates for the primary suspension

Differences of the load between the wheels are often corrected by adding shim plates.

Nencki can provide the following modules:

#### 3.3.1 Calculation of shim plates for primary suspension



In order to be able to calculate the height of the shim plates for the primary suspension either the stiffness of the primary springs (kN/mm) has to be entered into the PC manually or better to be calculated online during load application.

#### 3.3.2 Testing of springs before installing the bogie

Please note: Disassembling of suspension on a bogie needs a lot of time. It is more productive to test and combine the springs already before assembling the bogie. Nencki can also provide advanced spring testing solutions.

### 3.4 Calculation of shim plates for the secondary suspension

Normally the height of shim plates for the secondary suspension depends on the values of the height between T.O.R (Top of Rail) and top of secondary suspension.

The software module displays on which suspension which shim plate height should be added.

### 3.5 Measuring of height of points on top of the bogie frame

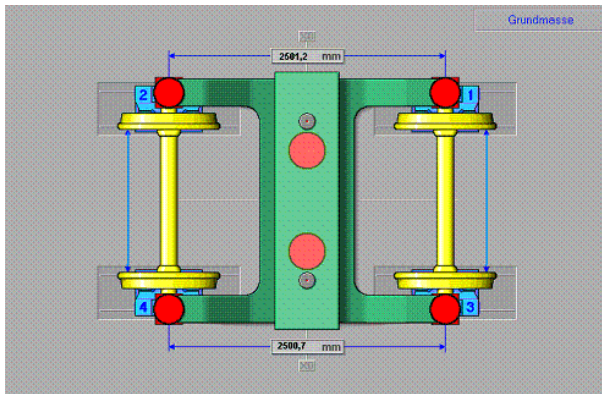
This traditional method is used mainly to measure the stroke of each suspension under different loads. Therefore the operator positions leveling rulers over the wheel onto the frame and measures the height or compares the height between the rulers with by an electronic digital leveling instrument. After pushing a button the value is transferred to the PC.

## 3.5.1 Digital leveling instrument:



Nencki provides the TOPCON DL digital leveling instrument. TOPCON is international represented. On request we can provide also other types as Zeiss, Trimble etc. In the scope of supply are a tripod and an interface to the PC of the bogie test stand.

## 3.6 Axle distance measuring, axle parallelism



Beside the wheel load, the axle parallelism is one of the most important characteristics which influences the running behavior of a bogie.

Bogies with non-parallel axes tend to drive always a curve. As a consequence excess wearing on the wheel / rail interface occurs as well as vibration and noise which the passengers will not appreciate.

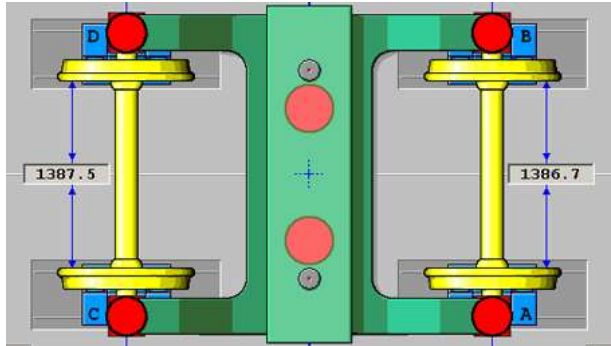
Famous rolling stock manufacturers of high speed trains recommend the measuring of the axle parallelism during production as well as in

the maintenance of bogies.

During application of load onto the bogie, the wheel measuring carriages can move in longitudinal direction (X) together with the wheels. Each movement is recorded online and precise with the help of the integrated linear measuring scales within +/- 0.1 mm.

The bogie axle parallelism is calculated from the difference between the r.h. and l.h. axle distance.

## 3.7 Measuring of wheel shoulder distance



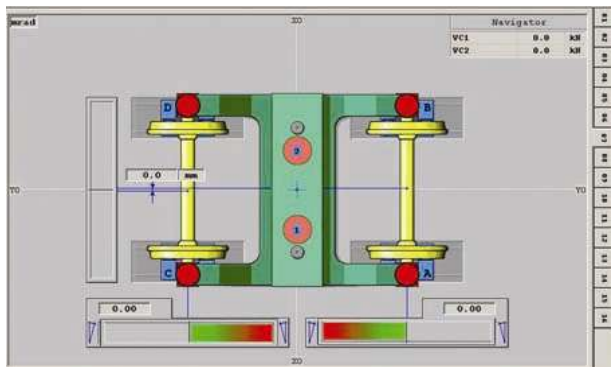
Also called “wheel back to back” or “wheel inner side” distance.

This distance shows whether the wheels have moved on the axle. In such case the gauge has changed. This function is specially needed in bogie maintenance shops.

With the help of two laser sensors the distance is measured fully automatic within +/- 0.2 mm Nencki standard includes the measuring in one position at the wheel rim.

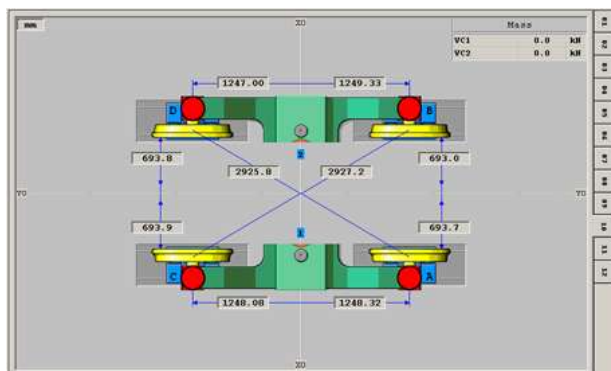
In some countries it is required to measure the wheel shoulder distance on several points on the wheel rim. In order to be able to fulfil this function fully automatic the wheels must be rotated on the bogie test stand as described in chapter “rotation of wheels”.

## 3.8 Axle angle



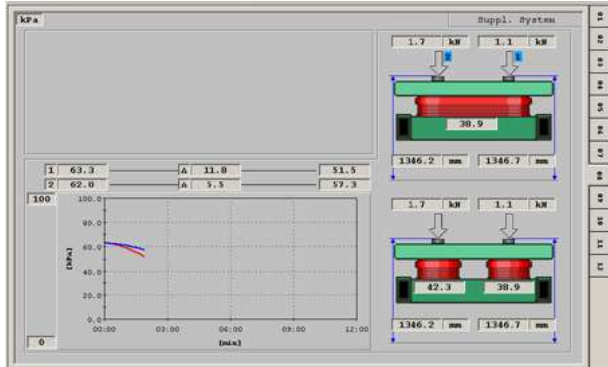
If the angle of the axles is not correct, the bogie tends to drive always in a curve. This causes more wearing on the wheel/rail interface, more vibrations and noise and disturbs the driving of a sinus curve, the so called wobbling.

## 3.9 Axle distance diagonal



In combination of wheel shoulder distance (indirect gauge measuring) and the axle distance the theoretical diagonal axle distance can be calculated.

## 3.10 Leakage test of air suspension



This function allows testing the leak proofness of the bolster under load and is an immense help to adjust the height of top of suspension over T.O.R. already on the bogie test stand.

After automatic pumping the required pressure into the bolster, the load will be applied during a free programmable time.

Any leakage would be recognized thanks to the electronic pressure difference control. Time and pressure are displayed online in a graphic. If the pressure difference is out of the

programmed tolerance, an error will be displayed.

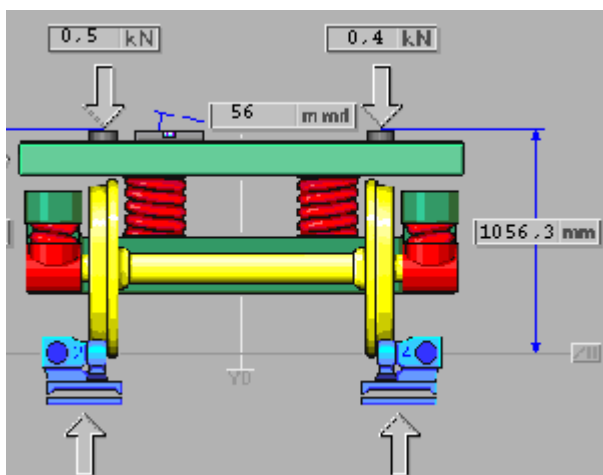
Additionally the height of top of the bolster compared with T.O.R is displayed as well. Thanks to those values corrections as e.g. equalizing the height on the right and left side of the bogie can be made easily.

Each bolster can be filled with air pressure and tested individually.

## 3.11 Testing of air leakage in the brake system

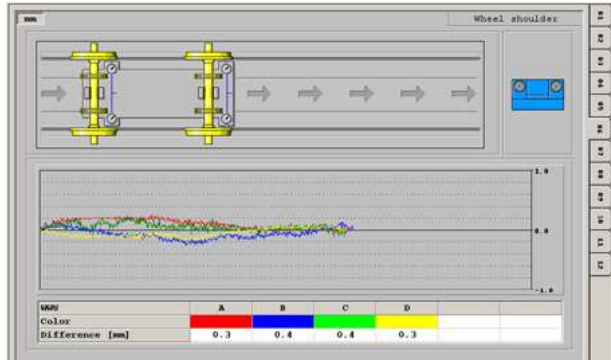
The above described air suspension leakage test unit can be e used as well for testing the leakage of air in the brake system. If required the bogie test stand can be equipped with a third (additional unit) for this test, which is more user-friendly.

## 3.12 Testing the function of the tilting mechanism



Some high-speed trains such as Pendolino have this function which allows the tilting of the vehicle on the bogie in order to achieve higher speed in curves.

## 3.13 Wheel “Run-out” measuring



Also called “wheel concentricity, “wheel out of balance”

Also this function is mainly used in maintenance shops. During rotating the wheels (only with very slow speed) the following described values can be measured and graphically recorded.

For these functions a “Y-Centering unit” is required.

### 3.13.1 Concentricity of the wheels in Y-direction. (Wheel shoulder)

The concentricity is recorded with the help of each single wheel shoulder distance sensor. It is shown in a curve and as an absolute value.

### 3.13.2 Concentricity of the wheels in Z-direction (diameter oval or not?)

The concentricity in vertical direction is recorded by means of rope governors. More about rope governor see also in chapter “Electronic rope governors”

The result is shown in a curve and as an absolute value.

## 3.14 Wheel diameter measuring

One reason for unequal wheel loads can be different diameters on the wheel. Therefore it is essential to know the exact wheel diameters. Nencki can provide the following alternatives for wheel diameter measuring:

### 3.14.1 Manual input of wheel diameters on the PC.

The customer uses his own diameter measuring instrument. The diameters can be entered on the PC manually.



### 3.14.2 Semi-automatic wheel diameter measuring.



The operator places the diameter measuring instrument on each wheel. Basing on 3-points, the diameter is calculated automatically and recorded.

With an optional interface the diameters can be transferred to the PC.

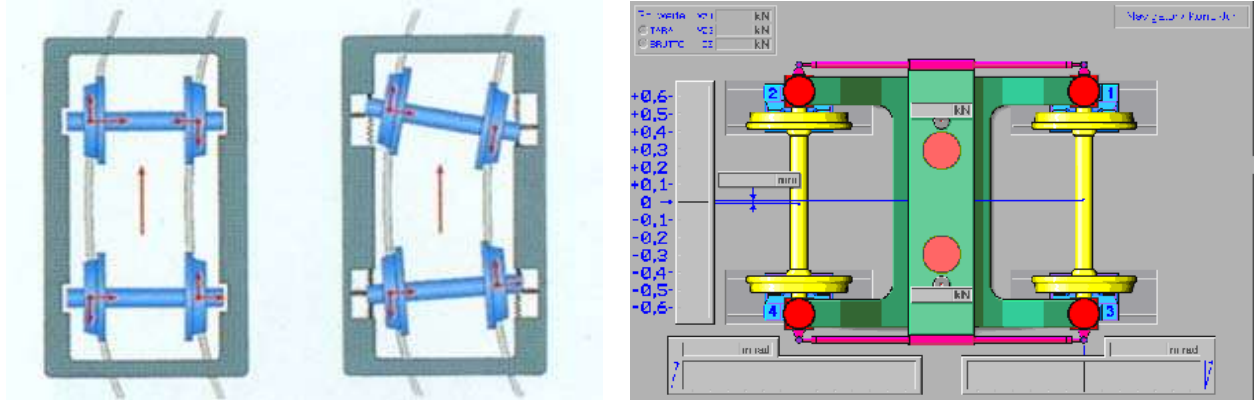
### 3.14.3 3. Fully-automatic wheel diameter measuring



While the bogie wheel is turning, a measuring wheel with integrated encoder records fully automatic the bogie wheel circumference.

The diameter is measured 70 mm (standard, other on request) from the wheel rim.

## 3.15 Testing of Navigator Function



Bogies with Navigator function also known as “Wheel steering bogies” and “Radial bogies”. Thanks to the technology of changing the angle of the axles during running, trains achieve higher speed in curve or metros are less noisy in curves.

## 3.16 Function test of the axle rotation sensor

This function is very interesting for maintenance shops. It shows whether the axle rotation sensor is working properly. While turning the wheels (wheel rotation unit necessary) the deflection comparison of the sensors value is made.

## 3.17 Axle rotating sensor

This allows the testing of the correct function of the mentioned sensor. Data output according to the customer specific sensor. Values such as power supply, signal evaluation, nominal and the actual transmitter values are possible.

In order to offer the correct solution, technical data of the axle rotating sensor should be specified before.

This function can be realized only with rotating wheels.

## 3.18 Wheel unloading test, $d Q/Q$

This test provides information about the behavior of the suspension at the end of curves or on uneven tracks.

While one wheel is lifted, the loads on the other wheels are measured. Interesting is the smallest wheel load (the unloading). After lifting each wheel, all smallest wheel loads are compared. A big difference would be an indicator that one of the primary suspensions is not working correctly.

This test is based on the EN 14363 standard.



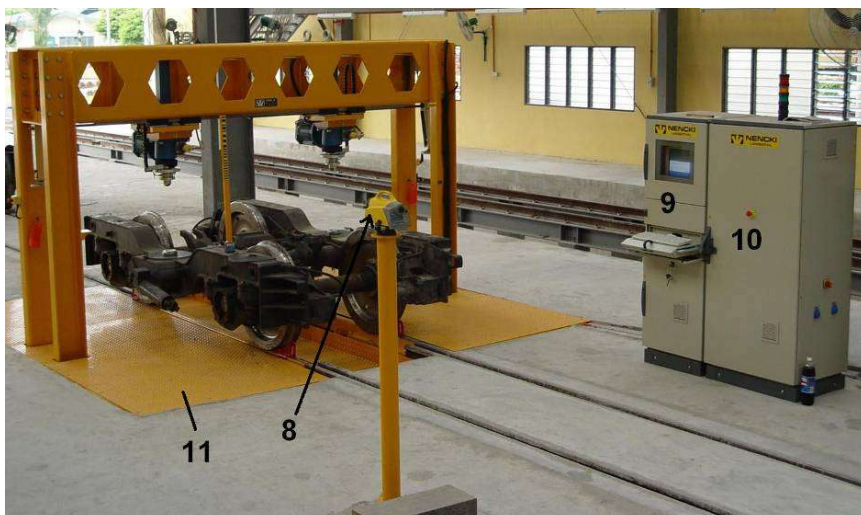
## 4 Mechanic

### 4.1 Components of the bogie test stand



- 1 = Load cylinder
- 2 = Horizontal beam
- 3 = Adapter
- 4 = Height adjustment
- 5 = Dropping rail
- 6 = Wheel measuring carriage
- 7 = Hydraulic unit

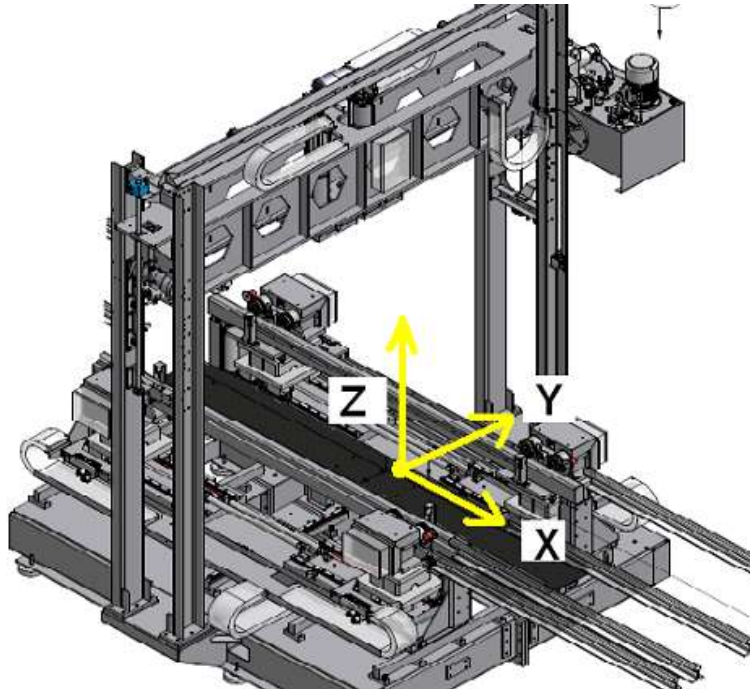
Photo Swiss Railways Yverdon



- 8 = Digital levelling instrument for measuring of heights
- 9 = PC cabinet
- 10 = Electro cabinet
- 11 = Floor cover

Photo KTMB Malaysia

## 4.2 Definition of the geometry of the Nencki bogie test stand



Z = Height

X = longitudinal in driving direction

Y = transversal

## 4.3 Positioning of the bogie test stand in the work-shop

### 4.3.1 The “pit-version”



Photo Pesa Poland

The rails in the workshop and the rails of the bogie test stand have the same level. The parts with the base frame and wheel measuring carriages stand in a pit under floor.

The bogies enter the test stand from on side and are leaving at the other side. This guarantees an efficient workflow and no additional handling is necessary.

## 4.3.2 The “over-floor version”



Photo Dalian Locomotive China

This solution is recommended if the civil construction of the building does not allow a pit or if the bogie test stand will be positioned after a certain period on another place.

The bogie test stand can be equipped with (an) additional support stand(s) on the in- and outlet side of the machine. Bogie must be lifted/dropped with the help of the enduser's crane onto/from the in-/outlet support stand.

## 4.4 The closed frame construction



Because to the closed frame design the Nencki bogie test stand is a detached contained unit such as a machine tool.

This design has the advantage that the test force is absorbed from the test stand itself - no force is applied to the floor of the user's workshop. This has, in comparison with a more economic solution which will be screwed with anchors directly onto the floor, the following advantages:

- No special foundation necessary. Foundation must bear the load of the machine and the bogie itself only
- The assembly of the machine is faster and easier
- The machine can be easily tested as a complete unit in the manufacturer's premises
- The precision of the machine is better

The base of the Nencki bogie test stand is a welded steel construction which can be separated into two parts for transportation. It is equipped with 16 pcs. (2- axle machine) anti-vibration leveling feet which allow the correct alignment of the machine during assembly.

Two rigid lateral twin columns support the horizontal beam with the load cylinders.



## 5 The test report

All test values are stored in the test result database and can be restored at any time.

If one of the test values that have been determined for a bogie lies outside the defined tolerance, the fault will be displayed and saved in the report. If a value is incorrect, then the bogie is assigned the status FAULTY in the report.

A report of totally eight pages report can be generated and printed. The end-user himself can create new test reports. It can be selected which values should be shown in which column, line and page.

### Bogie load test bench Datong Locomotive Works

### BLTB bogie test report

Bogie Report Set No.: 1      Testdate: 10-15-2002 04:20      Testcount: 27

Bogie Name: SS3B Teststatus: Report set finished Display text: Test step 2 Test load with report Serial no.: 23 Load set point 1: 70.0 kN Load set point 2: 70.0 kN Operator name: Graber Operator No.: 1234	Testdate: 15-10-2002  Set teststatus: <h1>Pass</h1>
---	---

Item:	MeNa	MeText:	Unit:	Minimum:	Maximum:	Effective:	OK?:
1	WD13	Distance axle	mm	2292.00	2308.00	2293.89	Pass
2	WD24	Distance axle	mm	2292.00	2308.00	2292.54	Pass
3	WD35	Distance axle	mm	1995.00	2005.00	2004.78	Pass
4	WD46	Distance axle	mm	1995.00	2005.00	2003.79	Pass
5	WB1	Wheel back distance axle	mm	1348.00	1358.00	1353.88	Pass
6	WB2	Wheel back distance axle	mm	1348.00	1358.00	1353.19	Pass
7	WB3	Wheel back distance axle	mm	1348.00	1358.00	1354.73	Pass
8	DY1	Lateral displacement axle	mm	-3.00	3.00	2.91	Pass

It is also possible to show graphics in the report.

The data are stored in an Access database. This open structure allows simple integration into higher-level systems.

## 6 Technical data (2-axle Bogie Test Stand NBT BASIC)

<b>Bogie dimensions and test load</b>	
Maximum bogie dimensions LxWxH in mm	Approx. 5000 x 3300 x 1200
Maximum bogie weight	12 to
Minimum axle distance	To be specified
Gauge fix	To be specified
Maximum test load, following versions available	2 x 250 kN 2 x 150 kN (standard)
<b>Machine dimensions</b>	
Machine dimensions, without hydraulic and electrical cabinet	L x W x H approx. 4500 x 4500 x 5000 mm
Machine weight approx.	13 to
<b>Hydraulic</b>	
Maximum pressure	240 bar
Tank	250 liter
<b>Electric supply</b>	
Voltage	3 x 400 V, 1 x 230 V, 50 Hz, +/- 5% Others on request
Fuse	63 A
Consumption	Approx. 22 kW/h Depending on the functions
<b>Accuracy of the machine</b>	
Precision of load application	+/- 100 N
Precision of wheel load measuring	+/- 200 N

## 7 Technical data (2-axle Bogie Test Stand NBT COACH)

<b>Bogie dimensions and test load</b>	
Maximum bogie dimensions LxWxH in mm	Approx. 5000 x 3300 x 1200
Maximum bogie weight	12 to
Minimum axle distance	1800 mm
Maximum axle distance	3000 mm
Gauges (fix or adjustable available)	850 - 1676 mm
Maximum test load, following versions available	2 x 250 kN (standard) 2 x 150 kN 2 x 300 kN
<b>Machine dimensions</b>	
Machine dimensions, without hydraulic and electrical cabinet	L x W x H approx. 4500 x 4500 x 5000 mm
Machine weight approx.	17 to
<b>Hydraulic</b>	
Maximum pressure	240 bar
Tank	250 liter
<b>Electric supply</b>	
Voltage	3 x 400 V, 1 x 230 V, 50 Hz, +/- 5% Others on request
Fuse	63 A
Consumption	Approx. 22 kW/h Depending on the functions
<b>Accuracy of the machine</b>	
Precision of load application	+/- 100 N
Precision of wheel load measuring	+/- 100 N
Precision of axle distance measuring	+/- 0.2 mm
Precision of air leakage measuring	0.05 bar

## 8 Technical data (3-axle Bogie Test Stand NBT LOCO)

<b>Bogie dimensions and test load</b>	
Maximum bogie dimensions LxWxH in mm	Approx. 7000 x 3300 x 1700
Maximum bogie weight	30 to
Minimum axle distance (axle 1 – axle 2)	2000 mm
Maximum axle distance (axle 1 – axle 3)	5000 mm
Gauges (fix or adjustable available)	850 – 1676 mm
Maximum test load, following versions available	2 x 300 kN Higher on request
<b>Machine dimensions</b>	
Machine dimensions, without hydraulic and electrical cabinet	L x W x H approx. 7500 x 4500 x 7500 mm
Machine weight approx.	25 to
<b>Hydraulic</b>	
Maximum pressure	240 bar
Tank	250 liter
<b>Electric supply</b>	
Voltage	3 x 400 V, 1 x 230 V, 50 Hz, +/- 5% Others on request
Fuse	63 A
Consumption	Approx. 22 kW/h Depending on the functions
<b>Accuracy of the machine</b>	
Precision of load application	+/- 200 N
Precision of wheel load measuring	+/- 200 N
Precision of axle distance measuring	+/- 0.2 mm
Precision of air leakage measuring	0.05 bar