DeltaSwitch

Installation & Maintenance manual

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1 Introduction

DeltaSwitch is a so-called "lubrication-free mechanism" that uses a pendulum that ensures the switch rails run smoothly and reach the desired end position. This document describes the assembly and installation, adjustment and maintenance of the DeltaSwitch.

1.1 Background

For switches with only one point machine there is a chance that the flange back of the open switch rail will be hit by the wheel flanges of a train. This creates a potential safety risk: frequent impact of the switch rail leads to varying loads on parts of the point machine, which can cause fatigue and wear. The problem mainly concerns switches with a single point machine and relatively long switch rails that rest on rollers in the open position. When the switch rail is hit by the inside of a train wheel, it flips back and will be repeatedly hit by the following wheels.

The DeltaSwitch with the "bistable pendulum" ensures that the switch rail is stable in both closed and open position and will not swing back and forth.
The pendulum mechanism uses the weight of the switch rail and ensures that the size of wheel flange clearance increases, reducing the chance of flange back contact. During the rearrangement, the switch rail is lifted over almost the entire length so that the friction with the sliding chairs disappears. DeltaSwitch therefore acts as a lubrication-free mechanism.

1.2 Scope

- *DeltaSwitch is mounted between the bearers of the switch panel:*
- *For switch panels having a risk that the required wheel flange clearance will not be achieved;*
- *For switch panels where the position of the open switch rail is instable;*
- *For standard switch panels, such as 1: 9, 1:12, 1:15 with bearers made of concrete, wood or plastic with centre to centre bearer distance from 580 to 620 mm.*

1.3 Applicable standards

Ref. nr.	Document	Version	Status
EN-13232	Railway applications - Track - Switches and crossings	October 2011	Final

1.4 Note regarding this document

Some images in this document may differ from the final version the DeltaSwitch pendulum will be delivered because here it concerns prototypes. The illustrated support plates are, for example, suitable for sliding chairs with a centre-to-centre screw distance of both 500 and 550 mm and therefore have four extra holes. The pendulum blocks shown are black, white or grey. The final version will be black.

2 Working principle of *DeltaSwitch*

The DeltaSwitch uses a fibre reinforced plastic pendulum that is rotatable around a steel pivot. This pivot (shaft) is part of the frame that is positioned between two bearers and is mounted under the sliding chairs of these bearers.

Because of the shape of the pendulum, the position of the switch rail will become stable in both extreme positions (see graph of appendix 2). To maximize the effect of the pendulum it is positioned at a specific location under the switch rail. The distance to the point machine differs depending on the length of the switch rail and its stiffness.

In figure 1 the half frame with shaft and pendulum is shown. The support plate enables mounting the DeltaSwitch frame just below two sliding chairs, the rubber plate below the support plate absorbs any unevenness and ensures that the support plate is electrically insulated from the bearer. Horizontal adjustment (across the switch rail) of the shaft is done by sliding the flange plate over the support plate. Vertical adjustment is done by hexagonal bolts at both sides of the pendulum to which the shaft is hanging.

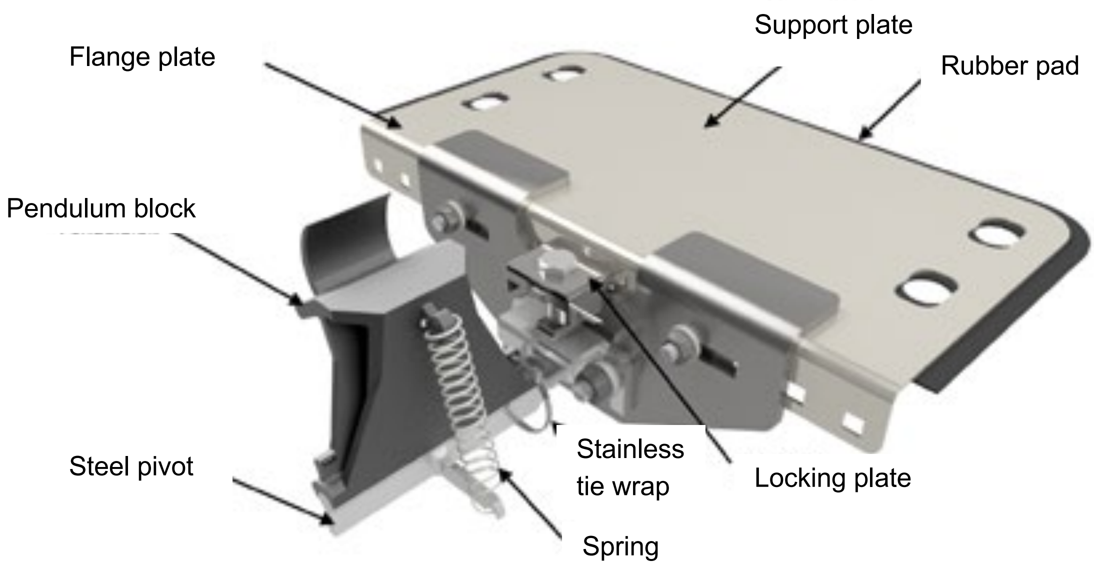


Figure 1: Composition of one suspension of the DeltaSwitch
(NB: the illustrated version with 8 holes in the support plate is suitable for normal and long sliding chairs. The most recent version has 4 holes, covering all bullet points mentioned in paragraph 1.2)

The pendulum is driven through the switch rail by friction. Figure 3 shows how the switch rail rests on the pendulum in the closed and open position. To prevent slip, the pendulum has a lip that is in contact with the foot of the switch rail and forces the pendulum to move synchronous with the switch rail. In the opposite direction a spring load forces the pendulum to move back with the switch rail, even when contact with the bottom of the switch rail is lost.

In the open position the switch rail is lifted 3 millimetres relative to the sliding chairs. This is because the distance from the pivot point to the right bearing plane is 3 mm more than the distance to the left bearing plane. Figure 2 shows the geometry of this pendulum. This has the shape of an asymmetrical kite that rotates around the lowest (pivot) point.

In the closed position the switch rail rests on the left surface of the pendulum. In this position the distance to the pivot is 120 mm. When the switch rail moves to the open position, the pendulum turns to the left and lifts the switch rail 6.3 mm and ends 3 mm higher. The graph in Appendix 2 shows the vertical movement as a function of the horizontal stroke of the switch rail.

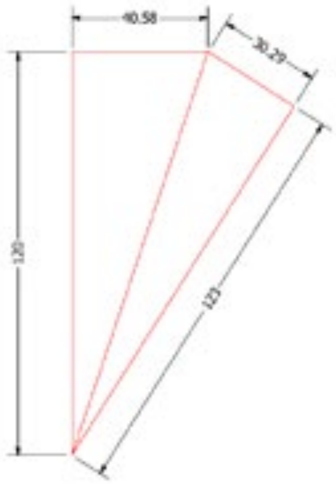


Figure 2: Geometry of the basic shape of the pendulum

Figure 3: Switch rail resting on the pendulum in both extreme positions.: descending (left) and closed (right)

3 Installation

3.1 Preamble

Mounting and adjustment of the pendulum is done under a closed switch rail. It is essential that the pendulum will not be loaded by the train. It must therefore be ensured that the pendulum is not set higher than the adjacent sliding chairs. For switches where the switch rail is free from the sliding chairs (also known as the cat's back), a special feeler gauge (Figure 6) is available, that facilitates mounting and adjustment of the pendulum in the correct position. With this feeler gauge, first the space between the switch rail and these sliding chairs is measured and then the feeler blade with the same thickness is placed on top of the pendulum during adjustment.

3.2 Required tools

The following tools are required to install a pendulum:
- ½ " ratchet with 19 mm cap (for M12 nuts) and 24 mm cap (for M16 nuts)
- 24 mm (open ended) spanner
- Torque wrench ½ “
- Pliers for bending the split pins
- Impact wrench (or heavy spanner) for collar bolts (fixing the sliding chairs to the bearers)
- *DeltaSwitch* feeler gauge (setting range: 1 to 6 mm)
- Tool (drawbar) for removing ballast underneath the switch rail
- Jack or railway jack (lifting capacity: > 5 tons)
- Two (glue) clips (80 x 200 mm)
- Putty knife or thin steel plate (to release existing washers and remove any unevenness from the turnout bearer)
- Crowbar with a minimum length of 80 cm (for lifting the switch rail)
- Hacksaw (depending on the type of switch rail stiffener: a hacksaw)

3.3 Positioning of the *DeltaSwitch* frame

Because a pendulum has a specific geometry that forces a certain horizontal stroke (approx. 70 mm), its position is determined by the length and stiffness of the switch rail.

Switch panel type	Length of switch rail	Distance to point machine	Position of frame between bearers
1:9 GW R195m	9.155 mm	3000 mm	7/8
1:7 – 1:15 R600m	9.155 mm	3000 mm	7/8
1:12 GW	1.0525 mm	4200 mm	9/10
1:15 GW R725m	1.0525 mm	4200 mm	9/10
1:15 GW Long Blade	1.1725 mm	4800 mm	10/11
1:20 SW	1.1100 mm	4800 mm	10/11

Table 1: DeltaSwitch pendulum frame position

Table 1 shows the optimum position of the DeltaSwitch pendulums per switch type. This table is based on specific switch panels. In Annexes 1a, 1b and 1c, the exact location of the device is specified for these switch types.

> **Note: For switch types not mentioned in the table, the position can be determined by choosing the location where the stroke is closest to 70 mm, when friction is eliminated. The latter can be achieved by lifting the switch rail with the crowbar.**

3.4 Mounting DeltaSwitch into a new switch panel

For new work, the frame of the pendulum (mainly consisting of: support plates, flange plates and shaft) is mounted on the bearers before the sliding chairs and the rest of the switch are mounted. The flange plates with the shaft are mounted so that the centre of the shaft is perpendicular to the inside rail foot of the switch (see figure 4). Then the sliding chairs and the other parts of the switch rail movement are mounted. It is important that the M12 lock bolts are inserted into the correct holes beforehand (otherwise the sliding chairs must be lifted again.) The other operations are described in the following section.

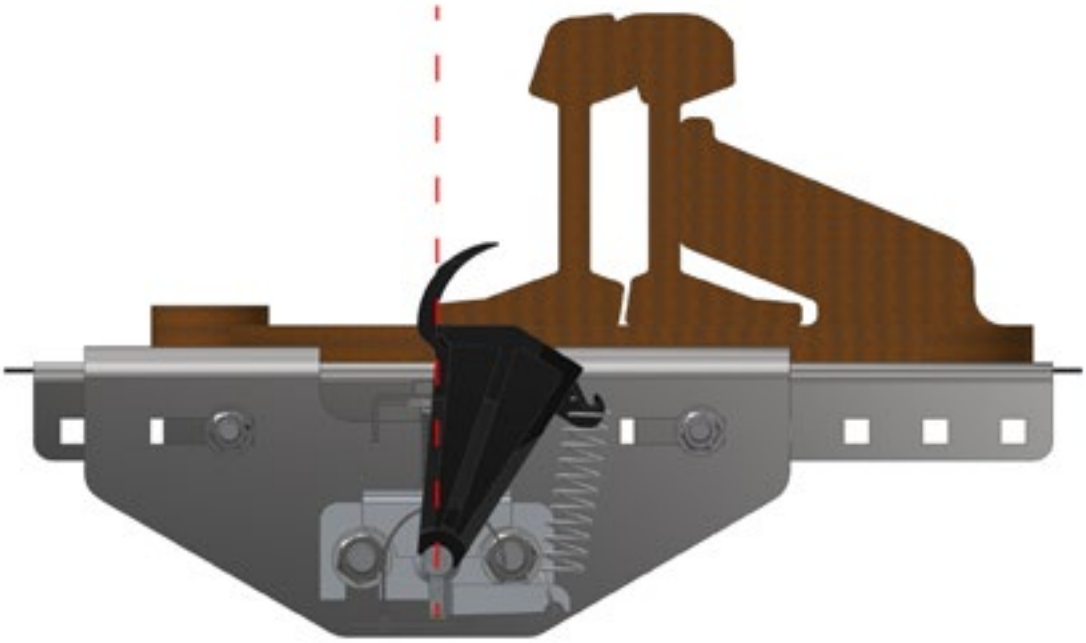


Figure 4: Horizontal position of the shaft

Figure 5: Overview of a built-in DeltaSwitch frame with pendulum

3.5 Mounting DeltaSwitch into the track

Part of the ballast has to be removed below the switch rail at the spot where the frame has to be mounted (see table 1). There must be a free space under the switch rail of approximately 20 centimetres. Also make sure that there is enough free space next to the switch rail to be able to slide the pre-assembled frame over the bearers, under the sliding chairs.
After the jack is placed in the ballast one sleeper distance away from the pendulum, the collar bolts in the sliding seats are loosened and removed. It is recommended to loosen the collar screws of adjacent sliding chairs as well, to relieve the lifting of the stock rail and sliding chairs. Now lift the sliding seats free from the bearers in order to replace the rubber insulation plate by the complete frame with the rubber plates underneath, which now can be slid under the sliding chairs and bring back the collar bolts.

In order to be able to adjust the shaft of the pendulum block, the (M12 and M16) nuts or the lock bolts are loosened and the securing plate on the (M16) adjusting bolts are removed.

Measure (if applicable) with the feeler gauge if there is more than 1 mm space between the switch rail and the sliding chairs of the two adjacent bearers. Make sure (and check with the crowbar) that the switch rail is in its close position. Place the pendulum block over the shaft with the corner of the lip against the base of the switch rail. If play is measured between switch rail and sliding chairs, the feeler gauge with the same thickness must be placed on top of the pendulum under the switch rail. The pendulum (with the feeler gauge in between – if applicable, see fig. 7) is then clamped against the switch rail with two clips as shown in figure 5.

While clamping, tap the pendulum block into the corner and to the side of the switch rail and adjust the shaft to the correct height (by hand-tightening the hexagonal bolts) and lateral positions. Ensure that the flange plates can freely move back and forth over the support plate so that the shaft can find its correct position (according to figure 4).

The pendulum block is secured against loss by two stainless steel tyraps (figure 6, right picture).

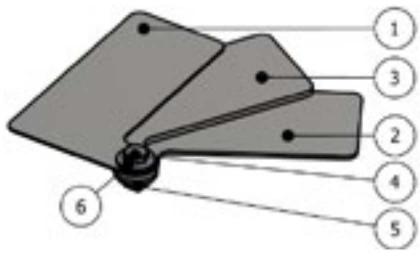
Figure 6a: The pendulum block is clamped against the switch rail using two glue clamps (right: stainless steel tie-wrap)

Now the hexagonal bolts on either side of the pendulum are fastened by hand until resistance is felt (and the switch rail completely rests on the pendulum). Secure these hexagonal bolts with the securing plates (with 12 angular holes) and split pins (Fig. 6b). Next, secure the shaft by tightening the (four) M16 nuts of the horizontal bolts.

Figure 6b: Locking plate with split pin. Right: tension spring

Finally, attach the spring between the pendulum and the hook (fig. 6, right picture) and check that all bolts and nuts are tight to the required torque. Now that the shaft of the pendulum is in the correct position, any feeler gauge (fig. 7) can be removed. For this, the switch rail can be lifted with the crowbar.

Torque of nuts secured with Nord-Lock washers: M12: 75 Nm; M16: 150 Nm.



Pos. 1 = feeler gauge, 1 mm
Pos. 2 = feeler gauge, 3 mm
Pos. 3 = feeler gauge, 2 mm
P4 t/m 6 = bolt, ring and nut
Material: Stainless steel

Figure 7: Feeler gauge for measuring and adjusting the pendulum in case the switch rail has a vertical shear ('cat's back')

Figure 8: DeltaSwitch with adjacent switch rail (top) and lowered switch rail (below).

4 Various switch rails and stiffeners

Two different switch rail stiffeners in use are described below. One of them requires the lip of the pendulum block to be shortened. This paragraph gives an instruction for trimming the lip.

In the standard version, the lip protrudes 42 mm above the adjacent flat surface. This means that this lip reaches a maximum of 42 mm above the bottom of the closed switch rail. For switches with a stiffener mounted on the switch rail, sometimes the lip must be shortened. The length to which the lip may be shortened is indicated by a dotted line on the lip with the following text: MINIMUM HEIGHT OF LIP.

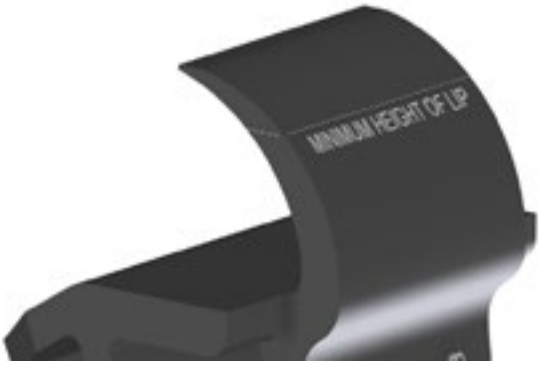


Figure 9: DeltaSwitch pendulum block with marking line on the lip

When shortening the lip, care must be taken that it is not shortened beyond the marking line. This is the minimum height for the lip to fully cover the toe of the switch rail in the open position. For a normal maintenance condition of the switch panel this is sufficient to prevent the lip from getting under the switch rail.
<u>Shortening the lip is not recommended if the switch panel shows extreme voiding of sleepers, especially when combined with a ‘cat back’ (sheer or space between switch rail and sliding chairs). For this may cause extreme vertical movement of the switch rail under train passage.</u>

4.1 Switch rail with stiffener made of a corner profile

For switches with a corner (or L-shaped) profile bolted to the switch rail, there may not be enough space underneath for the standard lip. In this case the lip needs to be shortened. (By the way: it is also possible to order the pendulum block with the lip shortened.)

Figure 9: Switch with L-shaped stiffener on the switch rail (switch panel without DeltaSwitch)

4.2 Switch rail without stiffener

Figure 10: DeltaSwitch pendulum block under the switch rail of a 1: 9 switch without stiffener

With this type of switch rail (without stiffener) the pendulum block can easily be built in. Note that adjustment always takes place in the closed position of the switch rail (as in figure 10).

4.3 Switch rail with stiffener made of a rectangular section

For switches with a rectangular tube for stiffening, there is (theoretically) a 45 mm distance between the bottom of the tube and the bottom of the switch rail. This leaves just sufficient space for the pendulum block to be placed with the long lip intact.

Figure 11: DeltaSwitch pendulum block under the switch rail reinforcement (rectangular tube)

5 Maintenance of the *DeltaSwitch*

The need for maintenance of the DeltaSwitch is limited. Because a steel shaft is used in combination with a fibre reinforced plastic pendulum, it does not need to be lubricated. The table below can be consulted to determine which maintenance should possibly be performed.

The parts to be maintained are listed in the first column. The function of the component, the failure modes and the associated causes as well as the consequences en required maintenance activities are listed in column 2 – 6.

The last columns give the frequency of preventive maintenance, the references to sources and a description of the follow-up actions required.

5.1 Maintenance table

For the ease of readability, the diagram is divided into two tables.

1. Part	2. Function of this part	3. Failure mode	4. Causes	5. Consequence
Pendulum	Facilitate smooth movement and stable end positions for the switch rail	Unstable end position, stroke of switch rail not complete	Built in at wrong position. Adjustment incorrect. Damaged Pendulum block	Flange back contact of train wheels. Track disruption
Frame	Positioning and support of the Pendulum between bearers in the switch panel	Loosening of nuts and bolts. Fracture or crack formation	Insufficient tightening of bolts and nuts, missing Nord-lock rings below nuts	Flange back contact of train wheels. Track disruption

Continued	6. Maintenance activity	7. Interval	8. Reference	9. Follow-up action
Pendulum	Visual inspection and checking adjustment of Pendulum	One week after installation	This document	Readjustment of Pendulum (in closed position of switch rail)
Frame	Checking bolts and nuts with torque wrench M12: 75 Nm M16: 175 Nm	Regular inspection interval (minimum 1/year); After track tamping	This document	Checking bolts and nuts and checking adjustment of the Pendulum

Table 2: Maintenance table

5.2 Maintenance and inspection required after trailing a switch

An incidental form of maintenance and inspection is a situation in which the switch was trailed by a train entering from the wrong direction. After trailing, the entire switch panel must be inspected in accordance with the Infra Managers' regulations. This also applies to the DeltaSwitch pendulum that may be damaged after trailing. The adjustment may also be disrupted.

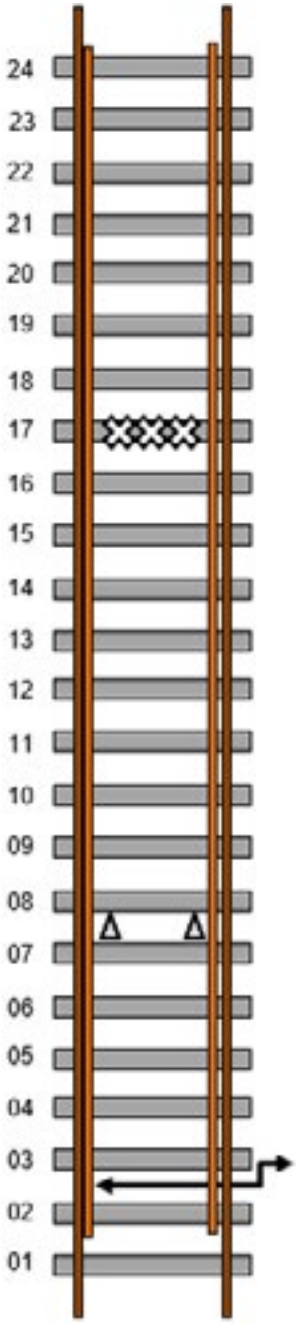
After trailing, the pendulum block must be taken out and this block and the entire frame must be checked for defects. Any damaged parts must be replaced and the pendulum must be installed and adjusted again.

6 Accompanying drawings

Drawing number	Title	Version	Datum
19.01.000	DeltaSwitch 54E1 – Assembly	3.0	9-3-2020
19.01.011	DeltaSwitch 54E1 – Pendulum block	3.0	6-2-2020
19.01.015	DeltaSwitch 54E1 – Pivot, assembly	3.0	5-3-2020
19.01.015-1	DeltaSwitch 54E1 – Pivot, parts	3.0	12-2-2020
19.01.016	DeltaSwitch 54E1 – Flange plate	3.0	5-3-2020
19.01.017	DeltaSwitch 54E1 – Support plate	3.0	5-3-2020
19.01.018	DeltaSwitch 54E1 – Rubber pad	3.0	5-3-2020
19.01.025	DeltaSwitch 54E1 – Locking plate	3.0	5-3-2020

Table 3: Drawings of DeltaSwitch

Appendix 1a DeltaSwitch for switches 1:7 to 1:15, R600m



With these switches with a switch rail length of 9.5 m, both DeltaSwitch pendulums are placed at 3 m from the point machine. This is between bearer 7 and 8 of the switch panel.
These switch rails are not provided with a switch rail reinforcement profile.

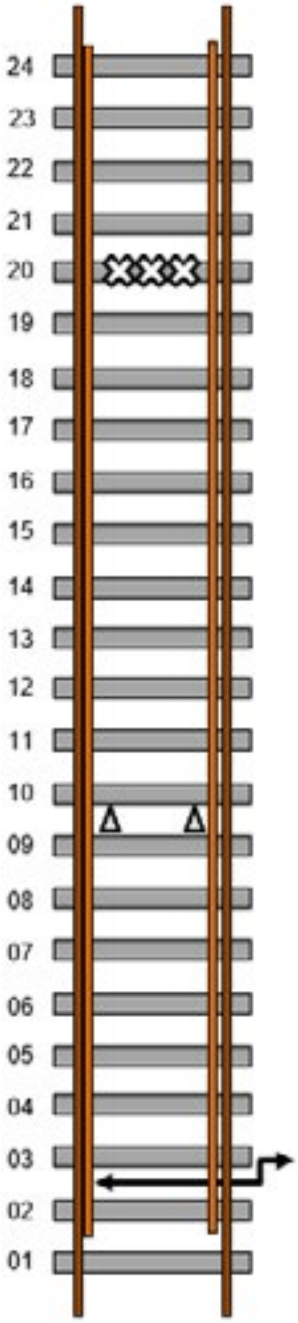
legend:

Switch rail fixation

Δ *DeltaSwitch* Pendulum

Point machine

Appendix 1b DeltaSwitch for switches 1:15, R725m



With these switches having a switch rail length of 10.9 m, DeltaSwitch is placed at 4.2 m from the point machine. This is between bearer 9 and 10 of the switch panel.

This placement is irrespective of the switch rail reinforcement.

If the switch rail has an angled profile, the lip of the pendulum block must be trimmed.

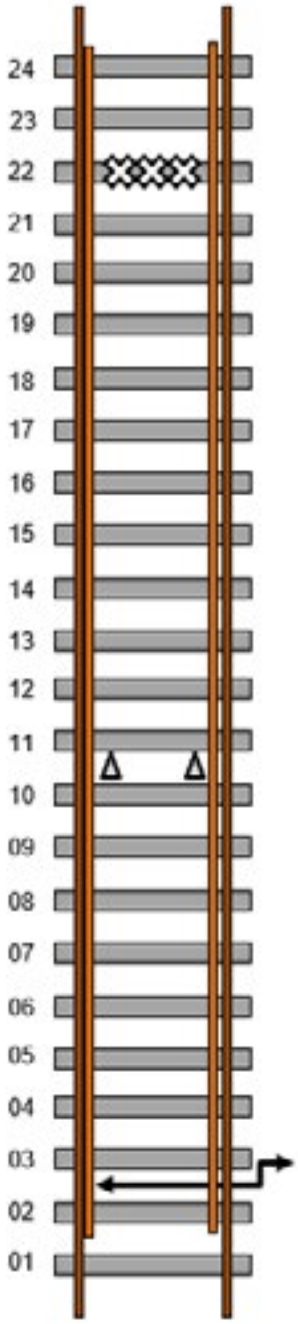
legend:

 Switch rail fixation

Δ *DeltaSwitch* Pendulum

 Point machine

Appendix 1c DeltaSwitch for switches 1:15 R725m, Long switch rail



In the switch panels with a switch rail length of 12.1 m, both DeltaSwitch pendulums are placed at 4.8 m from the point machine. This is between bearer 10 and 11.

With these switch types the switch rail is stiffened by means of a tube

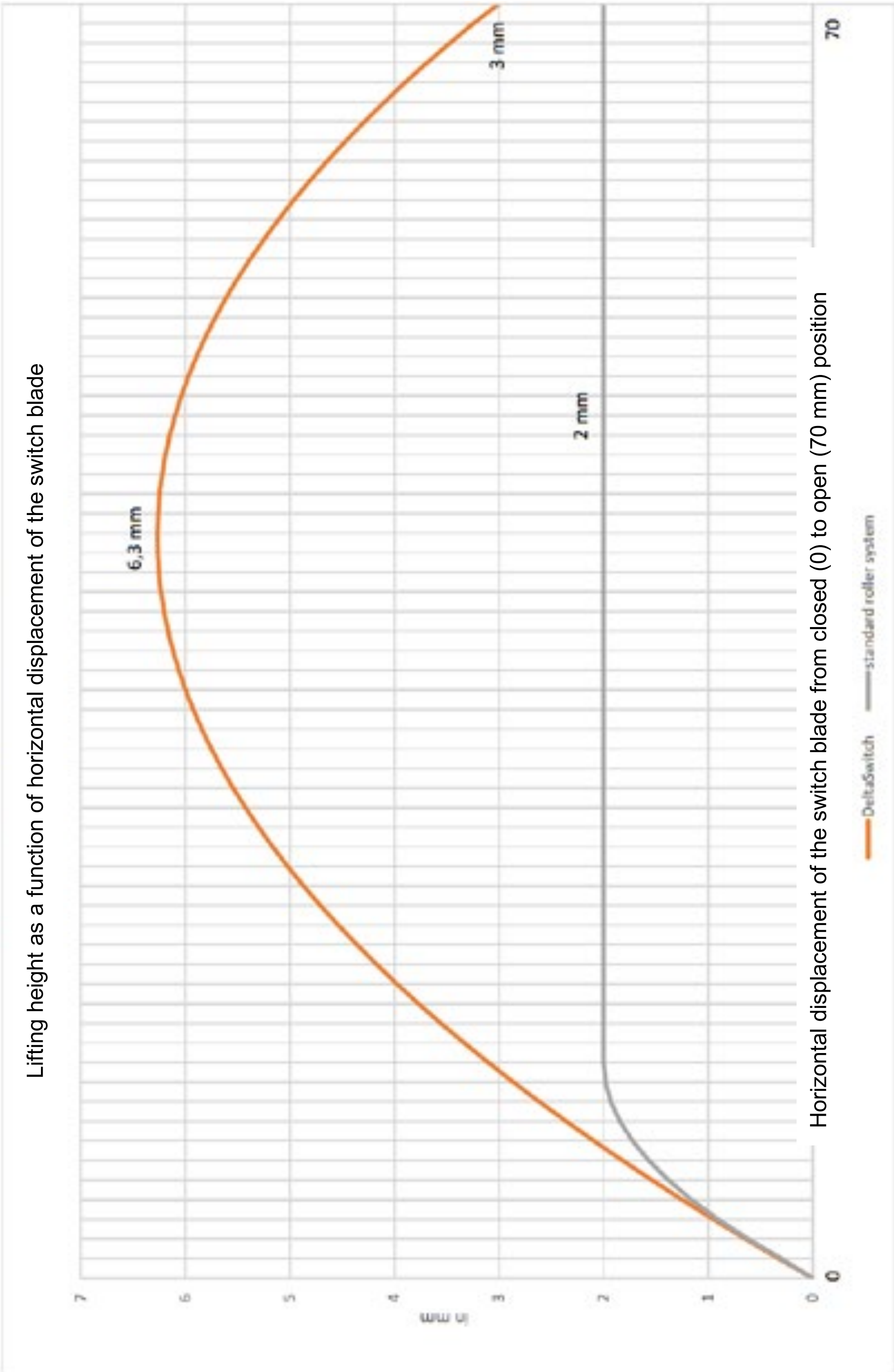
legend:

 Switch rail fixation

Δ *DeltaSwitch* Pendulum

 Point machine

Appendix 2 Vertical displacement of the switch rail



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