# INDEX

<table>
<thead>
<tr>
<th></th>
<th>INTRODUCTION</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DURALOK KNODE POINT</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>DURALOK SUPPORT SYSTEM COMPONENTS</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>ERECTION GUIDE</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>BRACING</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>SAFE WORKING LOADS</td>
<td>21</td>
</tr>
</tbody>
</table>

**APPENDICES:**

1) DURALOK KNODE POINT – GERMAN CERTIFICATE and TECHNICAL APPROVAL
2) TESTREPORT DURALOK BASIC SUPPORT SYSTEM
1) INTRODUCTION

In this manual you are introduced to the Supporting System of Scafom International bv, called DURALOK.

The system has been designed in order to be a very flexible and strong supporting system with the following advantages:

- minimum number of components to be required
- all components are designed to be robust
- all components are hot dip galvanised for durability
- fully systemised for ease of erection
- simple and efficient interconnection of standards, ledgers and braces
- standards and ledgers produced from 48,3mm, high grade steel
- high safe working loads
- variety of ledger-sizes to make different grid sizes and to allow maximum capacity of leg load
- system diagonals for accurate erection and bracing, easy to assemble and dismantle

The system is used world-wide and has been designed and manufactured according to the European standards EN-12812 and EN-12813. The system has been approved by:

- German Institute for Building Technology (DIBT, Zul. Nr Z-8.22-208), approval of knode point, see also appendix 1.
- Kunming University, verification of test results, see appendix 2.

Important:

The design of the formwork support system needs to be done by a competent engineer, taking into account all the loads that need to be supported and the load bearing capacity of the several components and the assembled structure.

The erection and application instructions in this manual are the recommended methods to be used for the original DURALOK system. Therefore the technical instructions need to be accurately followed to achieve the correct function of the DURALOK products. Any deviation from the recommended principles, shown in this manual, may require a separate verification by a competent engineer.

The illustrations and pictures in this manual, however, are guidelines only.

The erection and dismantling of the support system needs to be done by trained and skilled people.

The DURALOK system needs to be set up with original DURALOK components that are free from damages. Before starting to build a support system it is therefore necessary that all components are checked on good functionality. Damaged parts need to be immediately separated from good parts.

Never use damaged parts into a supporting system!
2 THE DURALOK KNODE POINT

The main construction of the DURALOK support system exists of standards, ledgers and braces. The connection between standards and ledgers is called the knode-point, see picture 2.1.

![Picture 2.1: DURALOK knode-point](image)

This knode-point exists of the blade end of the ledger (1), placed into the bottom cup (2) of the standard and locked up by hammering the top cup (3) against a fixed bar on the standard, into the engaged position. This fixation gives the system a rigid connection between ledgers and standards. The characteristics of the stiffness of this connection is shown in the German Approval (Z-8.22-208, see appendix 1) as well as the forces that can be taken up by the support system.

These forces are, see picture 2.2:

![Picture 2.2 Forces in knode-point](image)

\[
\begin{align*}
M_y, zul &= 138 \text{ kNcm} \\
N, zul &= 32 \text{ kN} \\
V, zul &= 13 \text{ kN}
\end{align*}
\]

Note: all mentioned loads are maximum Safe Working Loads (SWL).
3) DURALOK COMPONENTS

In this chapter, the various components of the DURALOK supporting system will be shown, according to picture 3:

- Pos. 01 = Adjustable base, par. 3.1
- Pos. 02 = Standard with spigot, par. 3.2
- Pos. 03 = Standard without spigot, par. 3.3
- Pos. 04 = Adjustable top-jack, par. 3.4
- Pos. 05 = Forkhead with cup, par. 3.5
- Pos. 06 = Ledger, par. 3.6
- Pos. 07 = Vertical brace, par. 3.7
- Pos. 08 = Adjustable brace, par. 3.8

Picture 3: Assembly of DURALOK components

On the next pages, the various components are shown in detail.
3.1 DURALOK adjustable base

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E04DL0167</td>
<td>Baseplate</td>
<td>2.2 kg</td>
</tr>
<tr>
<td>E02AA0278</td>
<td>Adjustable jack</td>
<td>4.2 kg</td>
</tr>
</tbody>
</table>

The adjustable base provides adjustment for the base standard. It fits into the standard and has a 48.3 mm diameter sleeve at the base of the stem to enable attachment of bracing, if necessary.

The stem of the adjustable base has a nut restraint feature to ensure to have a minimum of 250 mm insertion into the standard.

The minimum adjustment of the standard at the base is 140 mm; the maximum adjustment is 655 mm.

3.2 DURALOK standard with spigot

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E04DL0009</td>
<td>Standard with spigot 1.0 m</td>
<td>5.9 kg</td>
</tr>
<tr>
<td>E04DL0083</td>
<td>Standard with spigot 1.5 m</td>
<td>7.8 kg</td>
</tr>
<tr>
<td>E04DL0010</td>
<td>Standard with spigot 2.0 m</td>
<td>11.0 kg</td>
</tr>
<tr>
<td>E04DL0070</td>
<td>Standard with spigot 3.0 m</td>
<td>16.0 kg</td>
</tr>
</tbody>
</table>

The standards with spigots are used in conjunction with standards without spigots in order to achieve the height of the formwork support. See also next par. 4.1.

The standards are provided at the top with a spigot of 150 mm length to make vertical connections with other standards.

Also incorporated in the spigot and base of the standard, are holes with diameter of 13 mm to enable to use locking pins to interconnect standards if required.
3.3 DURALOK standard without spigot

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E04DL0006</td>
<td>Standard without spigot 1.3 m</td>
<td>7.0 kg</td>
</tr>
<tr>
<td>E04DL0007</td>
<td>Standard without spigot 1.8 m</td>
<td>9.5 kg</td>
</tr>
<tr>
<td>E04DL0008</td>
<td>Standard without spigot 2.3 m</td>
<td>12.1 kg</td>
</tr>
<tr>
<td>E04DL0171</td>
<td>Standard without spigot 2.8 m</td>
<td>14.7 kg</td>
</tr>
</tbody>
</table>

The standards without spigots are used at the top of the structure so that an adjustable forkhead can be inserted to provide the final support of the formwork.

The standards are used in conjunction with standards with spigots to build the structure to the correct height. The base of the standard has a hole with diameter of 13 mm to enable to use locking pins to interconnect standards if required.

3.4 DURALOK adjustable jack

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E02AA0278</td>
<td>Adjustable jack</td>
<td>4.2 kg</td>
</tr>
</tbody>
</table>

The adjustable jack provides adjustment for the forkhead on top of the structure. It fits into the open end of the standard without spigot and has an adjustable length of 515 mm.

The stem of the adjustable jack has a nut restraint feature to ensure to have a minimum of 250 mm insertion into the standard.
3.5 DURALOK forkhead with cup

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E05DL0004</td>
<td>Forkhead with cup</td>
<td>5,7 kg</td>
</tr>
</tbody>
</table>

The special designed DURALOK forkhead is placed on top of the adjustable jack to support main barriers and takes care that no horizontal loads will be transferred to the adjustable jacks. The forkhead can be stabilized by placing ledgers into the cup connection. The internal play of the tube of the forkhead and the adjustable jack make it even possible to place main barriers into a little slope.

3.6 DURALOK ledger

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E04DL0230</td>
<td>Ledger 0.3 m</td>
<td>1,4 kg</td>
</tr>
<tr>
<td>E04DL0025</td>
<td>Ledger 0.6 m</td>
<td>2,5 kg</td>
</tr>
<tr>
<td>E04DL0027</td>
<td>Ledger 0.9 m</td>
<td>3,7 kg</td>
</tr>
<tr>
<td>E04DL0029</td>
<td>Ledger 1.2 m</td>
<td>4,8 kg</td>
</tr>
<tr>
<td>E04DL0033</td>
<td>Ledger 1.8 m</td>
<td>7,1 kg</td>
</tr>
</tbody>
</table>

DURALOK ledgers are used as the main horizontal connecting members for the DURALOK support system. The ledgers are manufactured from 48.3 mm O.D. tubes with forged steel blade ends which locate into bottom cups of the standards and are locked in place by the corresponding top cups. Ledgers are available in various lengths to provide the desired grid dimensions when used with DURALOK standards for formwork support.
3.7 DURALOK vertical brace

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E05DL0006</td>
<td>Vertical brace 0.9x1.0 m</td>
<td>7.0 kg</td>
</tr>
<tr>
<td>E05DL0007</td>
<td>Vertical brace 1.2x1.0 m</td>
<td>7.8 kg</td>
</tr>
<tr>
<td>E05DL0009</td>
<td>Vertical brace 1.8x1.0 m</td>
<td>9.7 kg</td>
</tr>
<tr>
<td>E05DL0012</td>
<td>Vertical brace 0.9x1.5 m</td>
<td>8.5 kg</td>
</tr>
<tr>
<td>E04DL0013</td>
<td>Vertical brace 1.2x1.5 m</td>
<td>9.2 kg</td>
</tr>
<tr>
<td>E04DL0015</td>
<td>Vertical brace 1.8x1.5 m</td>
<td>10.7 kg</td>
</tr>
</tbody>
</table>

DURALOK vertical braces are used to stabilize the support system and to take up horizontal forces. There are various lengths of braces depending on the grid that is needed for the support system. The braces are placed on the horizontal ledgers as close to the node point as possible and fixed by hammering the wedges at both ends.

3.8 DURALOK adjustable brace

<table>
<thead>
<tr>
<th>Product nr:</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E05DL0001</td>
<td>Adjustable brace long 1,39-2,25 m</td>
<td>10.3 kg</td>
</tr>
<tr>
<td>E05DL0002</td>
<td>Adjustable brace short 0,95-1,39 m</td>
<td>13.1 kg</td>
</tr>
</tbody>
</table>

The DURALOK adjustable brace is a telescopic push/pull brace to diagonally brace the adjustable base on the bottom or the adjustable forkhead on top of the structure.

The adjustable brace can be fixed in every length in between the minimum and the maximum size by adjusting the pin in the inner tube and by screwing the both nuts. The brace is fixed onto the horizontal ledgers by hammering the wedges at both ends.

Depending on the grid sizes you can either use the short or the long version.
4 DURALOK ERECTION GUIDE

4.1 General – prior to erection

! The arrangement of the DURALOK grid will be determined by the formwork design and will be shown on the design drawing. This drawing needs to be the base guideline of setting out the structure.

! The ground must be assessed and verified to ensure it is capable of carrying the loads to be transferred to it. The ground must also be checked prior to erection to ensure construction processes have not changed the conditions since the formwork design was done.

! The precise grid arrangement is critical to the support of the loads, the design may not be deviated from except by written agreement with the formwork designer.

! The erection and dismantling of the support system may only be done by trained and skilled people.

! The DURALOK system needs to be set up with components that are free from damages. Before starting the erection all components therefore need to be checked on good functionality. **Damaged parts may never be used into the supporting system!**
4.2 Height definition of DURALOK support system

The height of the support structure is determined by the total standard length, the length taken up by the jack and base plate (140-655mm) at the bottom and the jack and forkhead at the top of the structure (298-798mm).

Be aware that the standards must always finish at the top with a support standard without spigot in order to be able to accommodate an adjustable jack.

Total standard height

The height made up by various combinations of standards is as an example shown in the next picture 4.2.1.
Be aware that ledgers need to be fixed at maximum every 1.5m height!

<table>
<thead>
<tr>
<th>Total Standard Height (m)</th>
<th>Support Height (m)</th>
<th>Access Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>1.80</td>
<td>2.30</td>
</tr>
<tr>
<td>1.8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2.8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3.3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3.8</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4.3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4.8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5.3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5.8</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6.3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6.8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7.3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7.8</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>8.3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>8.8</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9.3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9.8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10.3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Picture 4.2.1 Total height of support structure*
Base length

Picture 4.2.2 shows the adjustable range of lengths for the base jack.

![Base length diagram](image)

Top length

Picture 4.2.3 shows the adjustable range of lengths for the top jack and the forkhead. Be aware to have minimum 40 mm of jack-length for releasing the formwork before dismantling!

![Top length diagram](image)

To ascertain the overall length of standards required, deduct the base length and the top length from the overall soffit height.
4.3 Erection of the support system

At the start of the erection, the grid line of the supporting system needs to be marked out to ensure the legs of the structure are positioned correctly. Sole plates must be positioned under each adjustable base in order to spread the load effectively to the foundation.

Erection must start from the highest ground level to allow the best use of the adjustability of the bases. This must have been considered in the design so that each leg reaches its correct height.

The erection can start with putting the first four adjustable bases in the right position. Then two standards are placed over the bases (making sure that the standards are the correct size according to the drawing). A ledger is then connected to the lowest bottom cup on the standards joining the two standards together.

With one erector holding the first pair of standards, the third standard of the first bay is then placed in position over its adjustable base and is connected to the other standards with a ledger. The unit is then self standing and the remaining standard can be placed and connected.
In this way the first bay is formed, it must then be levelled by placing a spirit level on the top of the ledgers and adjusting the nut on the adjustable base taking care to maintain the lowest setting where indicated on the drawing. Be aware that all standards are erected plumb!

Whereas the base jack is screwed out more than 35 cm, the basejacks need to be braced by adjustable braces as well at the bottom of the structure.

After this, the first lift of ledgers is added and vertical braces are fixed to the two adjacent sides of the bay to maintain the rigidity of the bay. The braces need to be placed close to the knode point (e= less than 100 mm from the knode point).
From this bay other bays are erected in a similar manner.

If the structure has a birdcage layout (multi directional bay construction) then it is simply expanded outwards by adding new standards and connecting them to the structure with ledgers as applicable.

The structure is built upwards by fixing the ledgers every 1.5m in height. For more lifts in height adding additional standards as the drawing dictates.

For security reasons it is important to create safe working floors by placing (steel) planks on every new lift. The erectors need to be sure that they can do their work in a safe way on every level. Therefore they also need to be fixed to the structure with safety harnesses.
The last standard needs to be a standard without spigot to accommodate the adjustable forkhead.

To adjust the height of the structure, the jacks and forkheads need to be placed on top of the support standards without spigot.
To stabilise the forkhead, ledgers need to be connected into the welded cup on the forkhead.

After the structure has been erected the formwork bearers can be placed into the forkheads and levelled by means of the screw adjustment of the adjustable jack. The adjustable forkheads are braced with adjustable braces. Be aware that the bearers are placed in the centre of the forkhead. The maximum eccentricity may not be more than 5mm!
After finishing the supporting structure, the formwork can be placed on top of the structure.

However be aware:

! The structure needs to be inspected by a suitably experienced and competent person to ensure that it has been erected exactly according to the formwork design drawing.

4.3 Dismantling the support system

After the concrete has hardened, the supporting system can be released by releasing the adjustable braces and lowering the adjustable jacks.

Dismantling the support structure needs to be done in the opposite order of erection. Starting with dismantling the formwork, then the adjustable forkheads, the top horizontal ledgers, braces and standards, going down until finally the adjustable bases.

Be aware that during dismantling the stability of the structure needs to be maintained.

Components must be passed down from hand to hand and not dropped or thrown down onto the ground as this practice can cause injury to personnel and damage to the components!

Also at the stage of dismantling the erectors need to be sure that they do their job safely by using safety harnesses and creating safe working floors at every lift.
5 BRACING

Braces are required to give the supporting system strength and stability. Braces should be installed immediately after each lift has been erected and fixed to the ledgers as close as possible to the node points (not more than 100mm from the node point) to ensure that all bays are properly squared up.

In bridge support systems it is assumed that the formwork will create a stiff plane on top of the supporting system, that is held by the bridge columns. This means that the top deck is restrained externally in both directions.

The supporting system therefore needs to be restrained in longitudinally direction by the columns of the bridge by using tubes and fittings to lock up the supporting system. See picture 5.1, 5.2 and 5.3.

![Picture 5.1 Top view of bridge support (structure to be restrained at both ends at the columns)](image)

![Picture 5.2 Section A-A of bridge support](image)

![Picture 5.3 Section A-A of bridge support](image)
Further, bracing is depending on the possible horizontal loadings that can act on the supporting system. These horizontal loadings need to be specified for each and every project and the correct amount of bracing shall be calculated.

However a minimum number of braces must always be used!

Transversal bracing:

This requires single bracings in every row of standards in transversal direction from the bottom to the top, see picture 5.4 and 5.5; every row alternating from bottom to top and from top to bottom:

![Picture 5.4 Section C-C, transversal bracing](image1)

![Picture 5.5 Section D-D, transversal bracing](image2)

Longitudinal bracing:

Single bracing system spaced transversally of a maximum of 6 m (3 bays of 1.8) (or 5 bays of 1.2) (or 6 bays of 0.9), see pictures 5.2 and 5.3; also alternating in height direction.

Bracing of base jacks

In general, bracing of base jacks may be avoided wherever possible by designing the structure so that only the smallest jack extensions are required. This means no more than 350 mm.
6  SAFE WORKING LOADS

The load carrying capacity of any support structure is dependent upon several influencing factors which need to be taken into account. Every DURALOK structure must be designed to meet these prevailing site conditions:

1) Slab weight and live load
2) Spacing between standards
3) Height from ground to soffit level
4) Required jack extension
5) Ground conditions
6) Lift height

The load carrying capacity of the DURALOK support system, assembled according to the guidelines in this manual, with a lift height of 1.5m is maximum 60 kN per standard. This capacity of DURALOK is based on a grid distance of 1.8m and less.

This loading capacity is based on internal standards, restrained in all four directions. For external standards, restrained in either two or three directions, the safe working loads are reduced by 20%.

The loading capacity is also based on a maximum eccentricity of the loads on the forkheads of 5 mm.

Der Hersteller ist somit berechtigt, das oben genannte Bauprodukt mit dem Übereinstimmungszeichen (Ü-Zeichen) gemäß der Bauprodukte- und Bauarten-Verordnung zu kennzeichnen.

Das Zertifikat ist gültig bis 31.01.2011

München, 20.02.2006

Dr.-Ing. K. Ebert
(Leiter Zertifizierungsstelle)
General Technical Approval

Approval No.: Z-8.22-208

Applicant: SGB North Europe b.v.
Europaweg 97
5707 CL Helmond
THE NETHERLANDS

Object of approval: "CUPLOK" modular system

Valid until: 31 January 2011

General Technical Approval for the object of approval as specified above is herewith granted.*

This General Technical Approval consists of eleven pages and 13 appendices.

* This General Technical Approval replaces the General Technical Approval No. Z-8.22-208 dated 8 November 1995, as amended according to the notification dated 9 January 2001. The object was approved for the first time by a General Technical Approval / in accordance with building regulations on 8 November 1995.
I. General provisions

1. This General Technical Approval constitutes conclusive evidence of the usability and/or applicability of the object of approval in accordance with national and regional building regulations.

2. The General Technical Approval does not cover the permits, approvals and attestations required by law for the realisation of individual building projects.

3. The General Technical Approval is granted without prejudice to any third-party rights, including but not limited to private protective rights.

4. Without prejudice to any further regulations contained in the “Special Provisions”, manufacturers and distributors of the object of approval are under obligation to furnish copies of the General Technical Approval to the users and/or operators of the object of approval and to inform them that the General Technical Approval must be available at the place of use. Upon request, copies of the General Technical Approval must be furnished to the public authorities involved.

5. This General Technical Approval may only be copied in full. Any distribution of excerpts is subject to prior approval by the German Institute for Civil Engineering. Texts and drawings in advertising materials must not contradict the General Technical Approval issued by the building control authorities in any way. Any translations of this General Technical Approval into other languages must include the statement "A translation of the original German version not certified by the German Institute for Civil Engineering".

6. The General Technical Approval is revocable. The provisions of the General Technical Approval may be supplemented and/or amended at a later date, especially in the event of this being required by new technical findings.
II. SPECIAL PROVISIONS

1 Object of approval and field of application

The object of this General Technical Approval is the “CUPLOK” modular system for the construction of work and safety scaffolds and support scaffolds. The modular system consists of standards, ledgers and vertical diagonals, which are connected by special “CUPLOK” nodes. This General Technical Approval governs the production and use of the components.

The node consists of a Ø 48.3 x 3.25 mm coupling dish welded onto a standard tube and a conical swivel coupling dish undetachably clipped onto the standard tube. Ledgers with welded-on clamp fittings and vertical diagonals with welded-on or screwed-on (rotatable) clamp fittings are attached to the rigid coupling dish. To complete the connection, the swivel coupling dish is pushed over the clamps after they have been attached to the rigid coupling dish, and subsequently wedged in with hammer strokes, by rotation against a counter-bearing. Because of their conical shape and bevelled upper edge, the clamps are tightened by the rotation. The shape of the rigid coupling dish allows for the connection of tubes (ledgers and diagonals) branching off in any desired direction, provided that the direction is radial to the standard tube. A maximum of four rods can be connected to each coupling dish.

The provisions of DIN 4420-1 are applicable to the verification of stability of work and safety scaffolds, and the provisions of DIN 4421 apply to the verification of stability of support scaffolds. The load-bearing capacity and rigidity values of the nodes required for verification of stability are specified in this General Technical Approval.

The design and verification of facade scaffolds using this modular system requires a separate General Building Approval or a special permit in individual cases.

The “CUPLOK” node connected to a vertical diagonal with welded-on clamp fitting is illustrated in Appendix 1.

2 Provisions for scaffold nodes

2.1 Properties and composition

2.1.1 Components

The node must conform to the specifications contained in the appendices and to the documents submitted to the German Institute for Civil Engineering.

2.1.2 Materials

The materials of the scaffold node components must conform to the specifications contained in Table 1; their properties must be verified by the test certificates according to DIN EN 10204 as specified in Table 1.

2.1.3 Failure load of ledger connections

The failure load of the ledger connections (U ledger and tubular ledger connections) under tensile load is 63.0 kN.
2.1.4 Corrosion protection

The steel components must be adequately protected against corrosion as specified in the DIN EN ISO 12944 series of standards or by hot-dip galvanizing according to DIN EN ISO 1461.

Table 1: Technical regulations and test certificates for components of scaffold nodes

<table>
<thead>
<tr>
<th>Components</th>
<th>Material number</th>
<th>Abbreviation</th>
<th>Technical regulation</th>
<th>Certificate according to DIN EN 10204</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubes for vertical diagonals</td>
<td>1.0038</td>
<td>S235JR</td>
<td>DIN EN 10025-2</td>
<td>2.2</td>
</tr>
<tr>
<td>Counter bearing on the standard tube Ø 8 mm</td>
<td>1.0553</td>
<td>S355JO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubes for standards, tubular ledgers</td>
<td>1.0490</td>
<td>S275N</td>
<td>DIN EN 10025-3</td>
<td>3.1</td>
</tr>
<tr>
<td>Rigid coupling dish and clamp fitting for ledger</td>
<td>—</td>
<td>SG 420/12</td>
<td>BS 2789¹</td>
<td></td>
</tr>
<tr>
<td>Swivel coupling dish and clamp fitting for vertical diagonals</td>
<td>—</td>
<td></td>
<td>BS 2789¹</td>
<td></td>
</tr>
</tbody>
</table>

2.2 Production and marking

2.2.1 Production

Any companies producing the welded components of scaffold nodes as specified in this General Technical Approval must furnish proof of being sufficiently qualified to manufacture such components.

This proof is considered as furnished if the welding operation holds at least a Class C certificate (minor qualification certificate extended to the production of welding connections of steel with cast-iron workpieces) according to DIN 18800-7:2002-9 in accordance with the requirements for the production of welding connections according to this General Technical Approval. In this connection, welding procedure qualification tests on the components must be carried out according to the documents submitted to the German Institute of Civil Engineering.

2.2.2 Marking

According to the national and regional Mark of Conformity Ordinances, the individual components must be marked with

- the capital letter “Ü” (for Übereinstimmung = conformity),
- the abbreviated technical approval number “208” and
- the manufacturer’s trade mark.

Moreover, the last two digits of the year of production must be shown.

This type of marking is only permissible if the conditions specified under Section 2.3 have been met.

¹ BS 2789: 1985 Spheroidal graphite or nodular graphite cast iron available from:
BSI Standards 389 Chiswick High Road, London W4 4AL
2.3 Certificate of Conformity

2.3.1 General provisions

Confirmation of conformity for the components as specified in Table 1 and their connections with the provisions of this General Technical Approval must be furnished for every production plant by way of a Certificate of Conformity based on internal production monitoring and regular external auditing, including an initial test of the components as specified in Table 1 and their connections, in accordance with the regulations as specified hereunder.

For the issue of the Certificate of Conformity and external auditing, including the product tests to be carried out for this purpose, the manufacturer of the components as specified in Table 1 and their connections shall employ a recognized certification authority as well as a recognized inspection agency, both with appropriate qualifications in this area.

The said certification authority is under obligation to submit to the German Institute for Civil Engineering a copy of any Certificate of Conformity issued by it for information and perusal.

Furthermore, a copy of the initial test report must also be submitted to the German Institute for Civil Engineering for information and perusal.

2.3.2 Internal production monitoring

In every production plant, an internal production monitoring system must be set up and maintained. By internal production monitoring, continuous supervision of the production on the part of the manufacturer is to be understood, by means of which it is ensured that the components manufactured by him comply with the provisions of this General Technical Approval.

The internal production monitoring system shall include at least the measures specified hereunder:

- Inspection and testing of primary materials and individual parts:
  - It must be ascertained whether test certificates as specified under Section 2.1.2 are in existence for the materials and whether the test results certified therein comply with the requirements.
  - For a minimum of 10 components per production lot, but at least 1 ‰ of all components, the dimensional accuracy of all essential dimensions must be checked. The actual dimensions measured must be documented in each case.
  - The clamp fittings of the vertical diagonals must be inspected for absence of fissures.

- Tests to be carried out on finished scaffold nodes:
  - On at least 0.025 ‰ of the finished "rigid coupling dishes", an axial tensile load test with tubular ledgers to failure point must be carried out following connection to a standard tube. The tests to ascertain the failure load must be carried out according to the regulations laid down in "Zulassungsgrundsätze, Versuche an Gerüstsystemen und Gerüstbauteilen"² (the official guidelines for technical approvals, tests on scaffolding systems and scaffold components). The failure load must not fall below the value specified in Section 2.1.3.

The results of internal production monitoring must be recorded and analysed. The records must at least include the following details:

- Designation of the component
- Method of inspection and testing
- Date of production and testing of the components
- Results of inspection and testing and their comparison with the specifications
- Signature of the person responsible for internal production monitoring.

These records must be retained for at least five years, to be presented at any time to the German Institute for Civil Engineering and the supreme building control authority responsible upon request.

² Available from the German Institute for Civil Engineering
In the event of test results showing deficiencies, the manufacturer shall be obliged to take the necessary measures to remedy such deficiencies without delay. Any components that do not comply with the requirements must be handled in such a way as to exclude the risk of confusing them with components that meet the requirements. After remediing the deficiency, the relevant test must be repeated immediately, as far as technically feasible and necessary as evidence that the deficiency has been remedied.

2.3.3 External auditing

In every manufacturing plant, the internal production monitoring system must be inspected by external auditing at regular intervals, however at least twice per annum. As part of external auditing, initial tests of the components and their connections as specified under Section 2.1.1 must be carried out, and samples may also be taken for random checks. Such taking of samples and random checks are invariably the responsibility of the recognized auditing body.

At least the following tests must be carried out:

- It must be checked whether test certificates for the materials as specified in Section 2.1.2 are in existence and whether the certified test results comply with the requirements.
- On at least 5 units of each component as specified under Section 2.1.1, conformity with the dimensions and angles as specified in the drawings according to the appendices must be checked and compared with the permissible tolerances.
- On at least 5 units of each component, axial tensile load tests with tubular ledgers must be carried out as specified under Section 2.3.2.
- The prescribed marking of the components as specified under Section 2.2.2 must be checked. The components must be taken from ongoing production.

The results of certification and external auditing must be retained for a minimum of five years. They must be available at any time for presentation by the certification and/or auditing body to the German Institute for Civil Engineering and the supreme building control authority responsible upon request.

3 Provisions for design and dimensioning

3.1 General provisions

For the design and dimensioning of scaffolds to be constructed using the modular system, the general technical building regulations, especially those for work and safety scaffolds according to DIN 4420-1, and for support scaffolds according to DIN 4421, must be observed, unless specified otherwise in this approval notice. If the nodes are used in support scaffolds according to DIN 4421, the load capacities specified in the following paragraphs must be divided by 1.5 to calculate the maximum permissible load.

Evidence of stability for the scaffolds must be furnished in every individual case or by a static model calculation, unless such scaffolds are identical with a standard model for which a General Technical Approval has been granted.

The provisions specified in the following paragraphs are applicable to node connections including the connection between connector heads and the rods described in the appendices (ledgers and diagonals).

If vertical diagonals with welded-on or screwed-on clamp fittings are used in a scaffold, calculation of the rigidity must be based on the specific values of the vertical diagonals with screwed-on clamp fittings as evidence, and calculation of the load capacity on the specific values of the vertical diagonals with welded-on clamp fittings, unless the influence of such components has been included in detailed planning and calculation documents.
3.2 System assumptions

The static systems for calculating the node connections must be modelled as specified in Appendix 10. The short rods between the standard tube axis and the connections as described therein may be assumed as perfectly rigid. The indices specified in the subsequent paragraphs refer to a local coordinate system, in which the x-axis represents the ledger axis, and the z-axis the axis of the standard tube.

Transmission of axial forces and torsional moments in the connections of ledgers as well as bending moments and shearing forces in the plane between the standard tube and the ledger according to plan is permissible.

In the connection of diagonals, axial force transmission according to plan is permissible. The bending moment caused by the axial force components and the torsional moment are transmitted by the connecting structure and must be proved in both the standard tube and the ledgers.

In the subsequent paragraphs, the specific values of the node connections (load capacity, rigidity) given must be used as rated values, and the calculation of loads (stress resultants) must be based on the rated values of the various effects.

3.3 Ledger connection

3.3.1 Deformation behaviour under load

3.3.1.1 Bending in the horizontal plane

In the verification of scaffolds, the ledger connections in the plane formed by the standard tube and the ledger must be calculated with a torsion spring restraint according to the specific values given in Appendix 11, Figures 4 to 6.

For the verification of scaffold systems, calculation based on average bending moment stiffness values is permissible, if the following additional proofs are furnished:

- For the most unfavourable combination of loads, the load capacity must be proved with the assumption of minimal bending moment stiffness in all ledger connections, in which case calculation deviating from DIN 4420-1 and based on $\gamma_F = 1.15$ is permissible.
- In lieu of the maximum ledger connection moment, limit calculations with minimum and maximum bending moment stiffness must be carried out. The limit calculations can be carried out on simplified, localized systems.

3.3.1.2 Axial force in the ledger plane

In the verification of scaffolds, the ledger connections must be checked with a travel limiting spring with the specific values according to Appendix 12, Fig. 7.

3.3.1.3 Torsion

In the verification of scaffolds, the ledger connection must be checked under torsional load with a torsional restraint with the specific values according to Appendix 12, Fig. 8.

3.3.2 Proof of load capacity

3.3.2.1 General proof

On the connection of one ledger, it must be proved that the loads do not exceed the load capacities as specified in Table 2.
Table 2: Load capacities in a ledger connection

<table>
<thead>
<tr>
<th>Connection stress resultant</th>
<th>Load capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>bending moment $M_{y,R,d}$ [kNcm]</td>
<td>±208.0</td>
</tr>
<tr>
<td>positive vertical shearing force $V_{z,R,d}$ [kN] (in direction of &quot;fixed coupling dish&quot;)</td>
<td>+19.8</td>
</tr>
<tr>
<td>negative vertical shearing force $V_{z,R,d}$ [kN] (in direction of &quot;swivel coupling dish&quot;)</td>
<td>-16.5</td>
</tr>
<tr>
<td>torsion moment $M_{T,R,d}$ [kNcm]</td>
<td>±94.5</td>
</tr>
<tr>
<td>axial force $N_{R,d}$ [kN]</td>
<td>±49.2</td>
</tr>
</tbody>
</table>

3.3.2.2 Combination of stress resultants

For combinations of stress resultants in a ledger connection, the following condition must be met:

$$\frac{N}{N_{R,d}} + \frac{M_y}{M_{y,R,d}} + \frac{M_T}{M_{T,R,d}} \leq 1$$

with:

- $N, M_y, M_T$ being loads to which the ledger connection is exposed
- $N_{R,d}, M_{y,R,d}, M_{T,R,d}$ being load capacities according to Table 2

3.3.2.3 Interaction between standard tube and ledger connection

For coupling dishes under load, the following condition must be met:

$$I_A + I_S \leq 1$$

with:

- $I_A$ being the load factor in the ledger connection
- $I_A = \frac{M_y}{M_{y,R,d}}$

and:

- $M_y$ being the value of the bending moment in the ledger connection
- $M_{y,R,d}$ being the value of the bending load capacity in the ledger connection according to Table 2
and with:

\( I_S \) being the vectorial load factor in the standard tube near coupling dishes under load.

- The following applies to \( v_{act} < 1/3 \):

\[
I_S = \frac{a}{b} \quad (a, b \text{ see fig 1, with } b \text{ to be calculated from the interaction ratio according to fig. 1})
\]

- For \( 1/3 < v_{act} \leq 0.9 \), the vectorial load factor must be calculated on the basis of the interaction ratio according to the left side of the equation, column 4 of Table 7, DIN 4420-1:1990-12,

and with:

\( v_{act} \) being the load factor in respect of shearing force in the standard tube

\[
v_{act} = \frac{V_{St}}{V_{St,R,d}}
\]

\( V_{St} \) shearing force in the standard tube

\( V_{St,R,d} \) load capacity in respect of shearing force in the standard tube

\( V_{St,R,d} = V_{pl,d} = 53.7 \text{ kN} \)

Fig 1: Vectorial load factor in the standard tube

\[
\begin{align*}
V_{St} &= V_{St,R,d} = V_{pl,d} \\
M_{St} &= M_{St,R,d} = M_{pl,d} = f_{y,d} \cdot W_{el} = 194 \text{ kNcm} \\
n_{act} &= n_{St,R,d} = N_{pl,d} = f_{y,d} \cdot A = 147 \text{ kN}
\end{align*}
\]
3.4 **Vertical diagonal connection**

3.4.1 Deformation behaviour under load

In the entire system, the vertical diagonal connections must be checked with a travel limiting spring according to the specific values specified in Appendix 13, figures 9 to 11, depending on the model (welded-on or screwed-on coupling dish) and the number of connections to the coupling dish.

3.4.2 Proof of load capacity

For vertical diagonals, the following proof must be furnished, depending on the direction of load and the model (welded-on or screwed-on coupling dish):

\[
\frac{N_V}{N_{V,R,d}} \leq 1
\]

With:

- \(N_V\) being the axial force in the vertical diagonal
- \(N_{V,R,d}\) being the load capacity of the vertical diagonal in respect of axial force according to Table 3

### Table 3: Load capacity \(N_{V,R,d}\) of the vertical diagonal

<table>
<thead>
<tr>
<th>Load</th>
<th>Bay height (H) [m]</th>
<th>Bay length (L) [m]</th>
<th>(N_{V,R,d}) [kN]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vertical diagonal with welded-on clamp fitting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tension</strong></td>
<td>2.0</td>
<td>1.3</td>
<td>+ 14.5</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td><strong>Compression</strong></td>
<td>2.0</td>
<td>1.3</td>
<td>- 11.0</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.8</td>
<td>- 10.5</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>2.5</td>
<td>- 8.8</td>
</tr>
<tr>
<td><strong>Vertical diagonal with screwed-on clamp fitting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tension</strong></td>
<td>2.0</td>
<td>1.3</td>
<td>+ 20.9</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td><strong>Compression</strong></td>
<td>2.0</td>
<td>1.3</td>
<td>- 14.5</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.8</td>
<td>- 13.8</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>2.5</td>
<td>- 10.9</td>
</tr>
</tbody>
</table>

Bay height \(H\), bay length \(L\): see fig. 1
3.6 **Coupling dish**

For the connection of a ledger and a vertical diagonal, the following proof must be furnished:

\[
\frac{M_y}{M_{y,R,d}} + \frac{(N + N_v \cdot \sin \alpha)}{N_{R,d}} + \frac{M_T}{M_{T,R,d}} \leq 10
\]

with:
- \(M_y, N, M_T\) being the loads in the ledger connection
- \(N_v\) being the axial force in the vertical diagonal
- \(\alpha\) being the angle between the vertical diagonal and the standard tube (see Fig. 1)
- \(N_{R,d}, V_{z,R,d}\) load capacities according to Table 2

4 **Provisions concerning execution**

For the node components as specified under 2.1.1, only the rods as specified in the drawings as per the appendices may be used under this General Technical Approval. No more than four rods may be connected to each coupling dish.

Following connection of the clamps, the swivel coupling dishes of the nodes must be wedged in by rotational movements with a 500 g hammer to the final stop against the pin on the standard tube.

Only components marked as specified under Section 2.2.2 may be used.

Prior to assembly in a scaffold, the components must be checked for faultless condition. Damaged components must not be used.

Dr.-Ing. Kathage  
Certified
<table>
<thead>
<tr>
<th>DE</th>
<th>EN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alle Schweissnähte</td>
<td>All weld seams</td>
</tr>
<tr>
<td>Rohrriegel</td>
<td>tubular ledger</td>
</tr>
<tr>
<td>lose Tasse</td>
<td>swivel coupling dish</td>
</tr>
<tr>
<td>Vertikaldiagonale</td>
<td>vertical diagonal</td>
</tr>
<tr>
<td>feste Tasse</td>
<td>welded-on coupling dish</td>
</tr>
<tr>
<td>Ständerrohr</td>
<td>standard tube</td>
</tr>
<tr>
<td>Werkstoff:</td>
<td>Material:</td>
</tr>
<tr>
<td>Ständerrohr</td>
<td>standard tube</td>
</tr>
<tr>
<td>Rohrriegel</td>
<td>tubular ledger</td>
</tr>
<tr>
<td>Vertikaldiagonale</td>
<td>vertical diagonal</td>
</tr>
<tr>
<td>Lippe</td>
<td>clamp</td>
</tr>
<tr>
<td>Lippe für Diagonale</td>
<td>clamp for diagonal</td>
</tr>
<tr>
<td>Gerüstknoten</td>
<td>scaffold node</td>
</tr>
<tr>
<td>Übersicht (Diagonale feste Lippe)</td>
<td>Overview (diagonal with fixed clamp)</td>
</tr>
</tbody>
</table>

Anlage 1 zur allgemeinen bauaufsichtlichen Zulassung Z-8.22-208 vom 15. Februar 2006  
Deutsches Institut für Bautechnik  
Appendix 1 to the General Technical Approval No. Z-8.22-208 dated 15 February 2006  
German Institute for Civil Engineering
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Alle Schweissnähte</td>
<td>All weld seams</td>
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<tr>
<td>Rohrriegel</td>
<td>tubular ledger</td>
</tr>
<tr>
<td>lose Tasse</td>
<td>swivel coupling dish</td>
</tr>
<tr>
<td>feste Tasse</td>
<td>welded-on coupling dish</td>
</tr>
<tr>
<td>Vertikaldiaigonalay</td>
<td>vertical diagonal</td>
</tr>
<tr>
<td>Ständerrohr</td>
<td>standard tube</td>
</tr>
<tr>
<td>Werkstoff:</td>
<td>Material:</td>
</tr>
<tr>
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<td>standard tube</td>
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<td>vertical diagonal</td>
</tr>
<tr>
<td>Lippe</td>
<td>clamp</td>
</tr>
<tr>
<td>Lippe für Diagonale</td>
<td>clamp for diagonal</td>
</tr>
<tr>
<td>Sechskantschraube mit selbstsichernder Mutter</td>
<td>hexagon bolt with self-locking nut</td>
</tr>
<tr>
<td>Übersicht (Diagonale drehbare Lippe)</td>
<td>Overview (diagonal with rotatable clamp)</td>
</tr>
</tbody>
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Anlage 2 zur allgemeinen baubauaufsichtlichen Zulassung Z-8.22-208 vom 15. Februar 2006
Deutsches Institut für Bautechnik

German Institute for Civil Engineering
<table>
<thead>
<tr>
<th>Werkstoff:</th>
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<tr>
<td>SG 420/12 nach BS 2789</td>
<td>SG 420/12 according to BS 2789</td>
</tr>
<tr>
<td>Ansicht P1</td>
<td>View P1</td>
</tr>
<tr>
<td>Ansicht P2</td>
<td>View P2</td>
</tr>
<tr>
<td>Schnitt A-A und Schnitt B-B siehe Anlage</td>
<td>Cross-section A-A and cross-section B-B: see Appendix</td>
</tr>
<tr>
<td>Cup – Oberteil</td>
<td>Cup – top part</td>
</tr>
<tr>
<td>Deutsches Institut für Bautechnik</td>
<td>German Institute for Civil Engineering</td>
</tr>
<tr>
<td>Hersteller</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Jahreszahl der Herstellung</td>
<td>Year of production</td>
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<tr>
<td>Ansicht P3</td>
<td>View P3</td>
</tr>
<tr>
<td>Ansicht P4</td>
<td>View P4</td>
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<tr>
<td>Schnitt B-B</td>
<td>Cross-section B-B</td>
</tr>
<tr>
<td>Cup – Oberteil Details</td>
<td>Cup – top part in detail</td>
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Anlage 4 zur allgemeinen baufälliges Zulassung Z-8.22-208 vom 15. Februar 2006
Deutsches Institut für Bautechnik

German Institute for Civil Engineering
<table>
<thead>
<tr>
<th>Schnitt A-A</th>
<th>Cross-section A-A</th>
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</thead>
<tbody>
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<td>Werkstoff</td>
<td>Material</td>
</tr>
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<td></td>
</tr>
<tr>
<td>Jahreszahl der Herstellung</td>
<td>Year of production</td>
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<td>Manufacturer</td>
</tr>
<tr>
<td>Zulassungsnummer</td>
<td>Number of approval</td>
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<tr>
<td>Übereinstimmungszeichen</td>
<td>Mark of conformity</td>
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<td>Cup – Unteilel</td>
<td>Cup – bottom part</td>
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Anlage 5 zur allgemeinen bauaufsichtlichen Zulassung Z-8.22-208 vom 15. Februar 2006
Deutsches Institut für Bautechnik

German Institute for Civil Engineering
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<td>Material</td>
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<tr>
<td>Ansicht D</td>
<td>View D</td>
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<tr>
<td>Lippe</td>
<td>Clamp</td>
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<tr>
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<td>German Institute for Civil Engineering</td>
</tr>
</tbody>
</table>
Schnitt A

Cross-section A-A

Schnitt B

Cross-section B-B

Lippe Details

Clamp in detail

Anlage 7 zur allgemeinen baaufsichtlichen Zulassung Z-8.22-208 vom 15. Februar 2006
Deutsches Institut für Bautechnik

German Institute for Civil Engineering
Schnitt A
- Cross-section A-A

Schnitt B-B
- Cross-section B-B

Lippe für Diagonale Details
- Clamp for diagonal in detail

Anlage 9 zur allgemeinen baufachlichen Zulassung Z-8.22-208 vom 15. Februar 2006
Deutsches Institut für Bautechnik
- German Institute for Civil Engineering
Draufsicht:

Torsion

Bild 1: Statisches System Riegelanschluß
Fig. 1: Static system for ledger connection

Bild 2.: Statisches System Vertikaldiagonalanschluß (feste Lippe)
Fig. 2: Static system for vertical diagonal connection (fixed clamp)

Bild 3.: Statisches System Vertikaldiagonalanschluß (drehbare Lippe)
Fig.3: Static system for vertical diagonal connection (rotatable clamp)

Statische Systeme
Static systems

Anlage 10 zur allgemeinen bauaufsichtlichen Zulassung Z-8.22-208 vom 15. Februar 2006
Appendix 10 to the General Technical Approval No.
Z-8.22-208 dated 15 February 2006
Deutsches Institut für Bautechnik
German Institute for Civil Engineering
Last/Verformungsbeziehungen im Riegelanschluss

Load/deformation ratios in ledger connection

Mₘ/φ-Beziehungen bei Biegung in der Ebene Ständerrohr-Riegel

Mₘ/φ bending ratio in the standard tube / ledger plane

Bild 4: Mittlere Drehfedersteifigkeit

Fig 4: Average bending moment stiffness

Bild 5: Maximale Drehfedersteifigkeit

Fig. 5: Maximum bending moment stiffness

Bild 6: Minimale Drehfedersteifigkeit =

Fig.6: Minimum bending moment stiffness

mit Mₘ in kNcm

with Mₘ in kNcm

Last/Verformungsbeziehungen

Load/deformation ratios

Anlage 11 zur allgemeinen bauaufsichtlichen Zulassung Z-8.22-208 vom 15. Februar 2006


Deutsches Institut für Bautechnik

German Institute for Civil Engineering
Last/Verformungsbeziehungen im Riegelanschluss  

<table>
<thead>
<tr>
<th>Bild 7: Wegfeder bei Normalkraftbeanspruchung in Riegelachse mit N in kN</th>
<th>Fig. 7: Travel limiting spring under axial load in the ledger axis with N in kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bild 8: $M_T/\varphi$-Beziehung bei Torsion um die Riegelachse mit $M_T$ in kNcm</td>
<td>Fig. 8: $M_T/\varphi$ ratio in torsion around the ledger axis with $M_T$ in kNcm</td>
</tr>
<tr>
<td>Last/Verformungsbeziehungen</td>
<td>Load/deformation ratios</td>
</tr>
</tbody>
</table>
Load/deformation ratios in vertical diagonal connection

Fig. 9: Travel limiting spring in the connection of a vertical diagonal with welded-on clamp fittings

Fig. 10: Travel limiting spring in the connection of a vertical diagonal with screwed-on clamp fittings and max. number of connections to the coupling dish

Fig. 11: Travel limiting spring in the connection of a vertical diagonal with screwed-on clamp fittings and less than maximum number of connections to the coupling dish


Deutsches Institut für Bautechnik
DURALOK SUPPORTING System
loading testing Report

Laboratory Centre of Civil Engineering Department Kunming Science and Engineering University

July 27, 2009
1 INTRODUCTION

During July 17st to 21st, 2009 a loading test was carried out for Scafom International bv on 5 different specific towers erecting with Duralok supporting system by Laboratory Centre of Civil engineering Department Kunming Science and Engineering University. Scafom erects five different towers with the Duralok supporting system and installs the loading test equipment.

The CENTRE checks the loading test equipment made and installed by Scafom. The Centre proves the whole process of the loading test. They made the sensors doing real time detection in the whole loading process, and got the loading curve of the test to be sure the maximum loading capacity of the five scaffolding towers from these tests.

2 LOAD TEST

2.1 Test products

Five different Duralok system towers were erected by using five different configurations (see drawings in the appendix). Scafom offers and confirms the five designs about the structures which will be tested. The CENTRE proves that the structures erected by testing are the same as the designed ones.

2.2 Test target

Get the real time loading data in the whole process from the five different Duralok system towers. The testing software will automatically generate the time and load curved line relation to get the maximum load capacity of the scaffolding tower.

2.3 Test equipment

DH3817 Dynamic strain tester (precision: 1με), pulling sensor (precision: ±0.3%, repeatability: 0.2%) . Before testing, the sensor is checked and confirmed to get the indicating value and pulling curved line relation. The pulling capacity can be calculated according to indicating value of the sensor when doing the test.

2.3 Load method

The method of load is imitating the actual loading process in building environment. The following shows:

Put two H steel beams horizontal on top of the centre of the four vertical legs of the Duralok system tower, and then cross one more H steel beam on top of the middle of the two H steel beam horizontal, using a stake bar to connect the crossing H steel beam to the two-way hydraulic jack on the ground. The position is adjusted to be sure that the bar is vertical to the ground.
When loading, the hydraulic jack will drive the bar and the bar will drive the crossing H steel beam and the crossing H steel beam will pull the two horizontal H steel beams to centre the load to the four vertical legs of the tower. The sensor made by Laboratory Centre of Civil Engineering Department Kunming Science and Engineering University is linked to the stake bar system.

2.4 load program

Figure 1: load program figures

<table>
<thead>
<tr>
<th>Load grade</th>
<th>The hydraulic jack pressure (MPa)</th>
<th>duration (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.80</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>4.20</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>5.60</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>7.00</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>8.40</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>9.80</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>11.20</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>11.90</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>12.60</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>12.95</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>13.30</td>
<td>30</td>
</tr>
<tr>
<td>12</td>
<td>13.65</td>
<td>30</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>30</td>
</tr>
</tbody>
</table>

3 Test result

3.1 The maximum load capacity

The maximum load capacity comes out from real time curve of load.

Figure 2: different towers and the datas

<table>
<thead>
<tr>
<th>Number of tower</th>
<th>The actual load capacity in testing (KN)</th>
<th>Weight of 3 H steelbeam (Kg)</th>
<th>the maximum load capacity (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 #</td>
<td>400.4</td>
<td>500</td>
<td>405.4</td>
</tr>
<tr>
<td>2 #</td>
<td>397.1</td>
<td>500</td>
<td>402.1</td>
</tr>
<tr>
<td>3 #</td>
<td>405.7</td>
<td>500</td>
<td>410.7</td>
</tr>
<tr>
<td>4 #</td>
<td>395.5</td>
<td>500</td>
<td>400.5</td>
</tr>
<tr>
<td>5 #</td>
<td>400.2</td>
<td>500</td>
<td>405.2</td>
</tr>
</tbody>
</table>
3.2 The loading curve

No 1 tower loading curve

![No 1 tower loading curve graph](image1)

No 2 tower loading curve

![No 2 tower loading curve graph](image2)
No 3 loading curve

图 3 瓣扣式脚手架系统加载曲线（3#架）

No 4 loading curve

图 4 瓣扣式脚手架系统加载曲线（4#架）
No five loading curve

authorized: wen hongguang  approved: li Jianyun  main checked: houjie
Figure 1: the drawing of Duralok tower #1
figure 2: the picture of Duralok tower before loading 1#.

figure 3: the picture of Duralok tower after loading 1#.
Figure 4: the drawing of Duralok tower #2
figure 5 the picture of Duralok tower before loading 2#

figure 6 the picture of Duralok tower after loading 2#
Figure 7: the drawing of Duralok tower #3
附录图8 碗扣式脚手架系统实验破坏前（3#架）
figure 8 the picture of Duralok tower before loading 3#

附录图9 碗扣式脚手架系统实验破坏后（3#架）
figure 9 the picture of Duralok tower after loading 3#
Figure 10: the drawing of Duralok tower #4
附录图 11 碗扣式脚手架系统实验破坏前（4＃架）
figure 11 the picture of Duralok before loading 4#

附录图 12 碗扣式脚手架系统实验破坏后（4＃架）
figure 12 the picture of Duralok tower after loading 4#
Figure 13: the drawing of Duralok tower #5
Figure 14 the picture of Duralok tower before loading 5#

Figure 15 the picture of Duralok tower after loading 5#