



**SAH**  
Stahlwerk Annahütte

# SAS Referenzprojekte

*SAS reference projects*

**SAS SYSTEMS**



**MAX AICHER**  
UNTERNEHMENSGRUPPE





## Harbour installation, Køge Havn, Denmark

**SAS SYSTEMS**

- Project:** *Køge Harbour,  
permanent sheet pile wall construction for the harbour installation*
- Client:** *Køge Jorddepot*
- Construction period:** *December 2007 - December 2008*
- Main contractor:** *P. Aarsleff A/S*
- Supplier:** *Grønbech & Sønner A/S*
- Scope of supply:** *170 tons thread bars SAS 670/800 Ø 57.5 mm with length of 11.60 up to 12.60 m,  
for the anchorages 962 pcs. of joint bolts with special tempered anchor nuts in  
combination with joint nuts are used for tensioning the SAS thread bars*

### **Application:**

*Thread bars SAS 670/800 are used as tie rods for the permanent sheet pile wall construction. After the sand has been filled in between the walls, the H-Profiles, which are used for the bracing of the sheet pile construction, will be removed and the tension load is taken by the high strength SAS thread bars. Due to the small available space between the U-Profiles, joint bolts with special tempered anchor nuts in combination with joint nuts are used for the sheet pile wall anchorage.*



## Gateway Bridge, Brisbane, Australia

**SAS SYSTEMS**

- Project:** Gateway upgrade project in Brisbane, Australia
- Client:** QML - Queensland Motorway Limited
- Construction period:** September 2006 - May 2010
- Construction company:** Leighton Abigroup Joint Venture
- Supplier:** VSL Australia Pty. Ltd.
- Scope of supply:** 150 tons thread bars SAS 835/1035 Ø 75 mm for the bridge pile foundation system, SAS couplers allow a full load transfer of the SAS thread bars

### Application:

The new Gateway Bridge is supported by reinforced concrete columns with an outer dimension of 15 m length and 2.5 m width. The loads of the reinforced concrete columns are transferred to the reinforced concrete pile caps, which have an area of 19.5 m length, 17.6 m width and a thickness of 3.2 m and from there to the foundation piles with a diameter of 1.8 m. The pile heads are reinforced with thread bars SAS 835/1035 to provide vertical and horizontal post tensioning in the main pier heads.



## **Dry Dock, Dubai, UAE**

**SAS SYSTEMS**

- Project:** *Dry Dock in Dubai, UAE*
- Client:** *Dry Docks World*
- Construction period:** *February 2008 - March 2009*
- Construction company:** *Dutco Balfour Beatty*
- Supplier:** *VSL Middle East LLC*
- Scope of supply:** *219 tons thread bars SAS 670/800 Ø 63,5 mm,  
23 tons thread bars SAS 670/800 Ø 57,5 mm,  
1,300 pcs. couplers, nuts and anchor plates*

### **Application:**

The high strength thread bars SAS 670/800 were used as tie rod application of a pile wall. The total length of the SAS tie rods between the pile walls were 31.5 m. SAS couplers and nuts made the mechanical connection of the thread bars possible. For a permanent corrosion protection, the SAS thread bars were cleaned, brushed, coated with a primer and wrapped with a tape. PVC pipes were used additionally to protect the tie rods against mechanical damages. Compared to conventional tie rods, SAS thread bars are less heavy at the same load capacity and therefore easy and safe handling is guaranteed with the SAS tie rod system.



## Cross-city link, Zurich, Switzerland

**SAS SYSTEMS**

**Project:** Zurich cross-city link Altstetten  
Zurich HB - Oerlikon, line section 4, connection Oerlikon, section 4.005

**Client:** Swiss Federal Railways, Kanton Zurich

**Construction period:** October 2007 - June 2009

**Construction company:** ARGE Spezial-Tiefbau

**Supplier:** Joint Venture VSL Switzerland Ltd. and Spannstahl AG

**Scope of supply:** 72 km pre-grouted thread bars SAS 500/550 Ø 32 mm, (~ 454 tons),  
7,600 pcs. anchor heads (domed washer and dome nut)

### Application:

Due to the work on the railway system and the existence of stray currents, a permanent corrosion protection of the rock anchors - thread bars SAS 500/550 - are necessary for slope protection. Altogether, 7,600 anchor heads with 72.5 km electrically isolated rock anchors with thread bars SAS 500/550 are installed. Before and after grouting of the cement mortar, the electrical resistance of the permanent rock anchors is measured. On the basis of the high bonding characteristics of the thread bars SAS 500/550 with the pre-grouted cement mortar, the technical requirements of electrically isolated rock anchors are fulfilled excellently.



**Al Salam Street, Abu Dhabi, UAE**

**SAS SYSTEMS**

- Project:** *Upgrading Al Salam Street and Abu Dhabi City Ring Road, contract No. (1) Al Salam Street Tunnel*
- Client:** *Department of Municipal Affairs, Abu Dhabi Municipality, UAE*
- Construction period:** *May 2008 - October 2010*
- Construction company:** *Samsung - Saif Bin Darwish JV*
- Supplier:** *VSL Middle East LLC*
- Scope of supply:** *280 tons thread bars SAS 670/800 Ø 28, 43, 57,5 and 63,5 mm, 2,585 pcs. couplers, 796 pcs. anchor plates and 1,153 pcs. anchor nuts*

**Application:**

*With a tunnel of about 4 km length the underpass of the Salam Street is completed. The Al Salam Street is a four lanes road with connection to the expressway Mina Road. For stabilization of the pits thread bars SAS 670/800 are used as tie rods for the retaining walls. A higher load carrying capacity compared to conventional reinforcing steel and an easy, fast and safe installation of the SAS thread bar system are the main advantages even in cramped areas of construction site.*



**MCE Expressway, Singapore**

**SAS SYSTEMS**

- Project:** MCE 485 Marina Coastal Expressway in Singapore
- Client:** LTA - Land Transport Authority
- Construction period:** August 2009 - December 2011
- Construction company:** Penta Ocean Construction Co. Ltd.
- Supplier:** VSL Singapur
- Scope of supply:** 1,300 tons post-tensioning bars SAS 950/1050 Ø 32 mm with couplers and fix nuts

**Application:**

It is the most expensive expressway of Singapore and it is the traffic connection between the east and west part of Singapore. With five lanes for each direction, the expressway has a total length of 5 km, where of 3.5 km are realized as a tunnel. SAS piles with post-tensioning bars are used because of the existing soft soil layers (soft marine clay) up to a depth of ~57 m. SAS piles are used temporary for the negative buoyancy (tensile) and permanent as foundation piles (compression). With a total length of 70 m SAS piles are connected fast, easy and safe with couplers and fix nuts based on single bar sections with lengths of 11.8 m.



**Costa Concordia, Giglio, Italy**

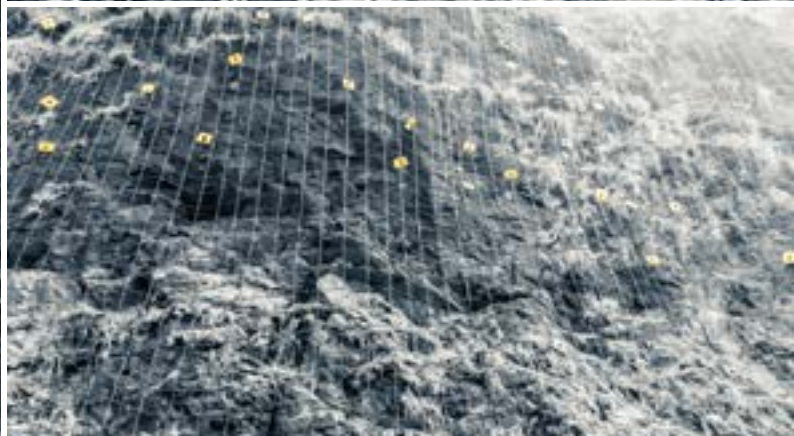
**SAS SYSTEMS**

- Project:** Salvage of Costa Concordia
- Client:** Trevi S.p.A. (subcontractor of main contractor Titan Salvage and Microperi)
- Construction period:** 2012-2013
- Construction company:** TREVI S.p.A.SASITA s.r.l.
- Supplier:** TREVI S.p.A.SASITA s.r.l.
- Scope of supply:** Approx. 140 temporary ground anchors factory preassembled and pregrouted with corrosion protection compound: in total 57 tons of thread bars SAS 670/800 Ø 75 mm und 63,5 mm, as well as additional accessories in the bond length of the ground anchor

**Application:**

The salvage concept of the ship Costa Concordia that was damaged close to the isle of Giglio, Italy in January 2012 considers the re-erection of the ship by use of a lever action induced by strand tendons and hydraulic jacks. The acting deviation forces at the steel structure between the ship and the shore line are anchored by SAS ground anchors grade SAS 670/800 placed in under water foundation blocks. For this project the structural designer of the company assigned for the salvage and our customer TREVI S.p.A. together with the research- and development team of SAH developed a special project related ground anchor design, that was rapidly realized together with our Italian subsidiary SASITA s.r.l.. The SAS ground anchors were covered by PE tubes within the free length. The annular space is then pregrouted with corrosion protection compound at the factory to ensure later both free elongation during stressing and a high corrosion protection of the SAS thread bar.





**Landslide Protection - MH4, India**

**SAS SYSTEMS**

**Project:** Landslide Protection Near Adohsi &Kandala Tunnell - MH4 (Pune-Mumbai Hyway)

**Client:** Maharashtra State Road Development Corporation Limited (MSRDC)

**Construction period:** October 2015 - February 2016

**Construction company:** Maccaferri Environmental Solutions Pvt. Ltd.

**Supplier:** SAS Asia Bar Systems Pte. Ltd.

**Scope of supply:** Galvanized SAS500 soil nails, diameter 25 mm and 32 mm

**Application:**

The project is for the supply of B500 bolts in diameter 25 mm and 32 mm respectively installed in bore holes of 40 mm and 60 mm. The EPC contractor uses Rope Access climbers to drill the hole and install the anchors. With the busiest road in Maharashtra, India, authorities decided to materialize the project quickly in order to stop any more incidents of rock falling which already claimed 3 lives, SAS anchors are selected to protect lives and to protect against rock fall from mighty terrains.



**BR 040 Road, Rio de Janeiro, Brazil**

**SAS SYSTEMS**

- Project:** BR 040 Road, Rio de Janeiro, Brazil
- Client:** Progeo Engenharia Ltda.
- Construction period:** January 2015 - July 2016
- Construction company:** CON CER - Companhia de Concessão Rodoviária Juiz de Fora-Rio
- Supplier:** SAS Protensão
- Scope of supply:** 150 tons SAS 950 /1050 thread bars of 36 mm, and 1,100 pcs. anchor heads  
All material supplied with epoxy-corrosion protection according Brazilian code NBR 5629.

**Application:**

Construction between Rio de Janeiro and Petropolis cities, this project will have 15 km of doubling roads and the biggest tunnel of Brazil with 5 km of extension. SAS Protensão supplied the anchors to the containment slopes. All materials supplied with permanent corrosion protection according Brazilian code NBR 5629. The project was constructed with the road functioning. The SAS 950 /1050 thread bars of 36 mm was indicated because your technical characteristics like low weight to the workers, and durability.



## Peñón de Cortijo, Bogota, Colombia

**SAS SYSTEMS**

**Project:** Peñón de Cortijo, Bogota, Colombia

**Client:** Alcaldía Local Ciudad Bolívar

**Construction period:** April 2015 - December 2015

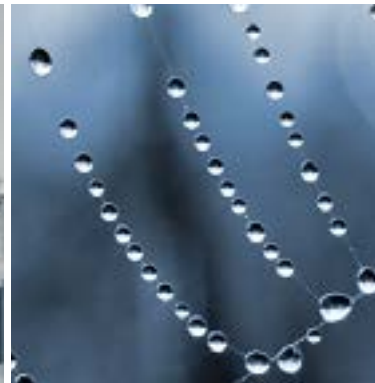
**Construction company:** Jeinco

**Supplier:** Warco

**Scope of supply:** 48 ton of SAS 500 (grade 75) diameter 32 mm thread bars, coupled in length of 4 meter

### Application:

The project is located in the south of Bogota (Colombia), it consists of a slope stabilization. The lower part of the slope had suffered from rock fall and the houses were suffering from cracks. It was decided to secure the slope with the system SPIDER from Geobrugg geotextile, tied down with SAS 500 bars in diameter 32 mm. The pattern selected was 3,0 x 3,0 m in the whole slope and the working load was between 3-5 tons.



## *Sport City Tower, Doha, Qatar*

**SAS SYSTEMS**

**Project:** *Sport City Tower in Doha, Qatar. The external facade of the 320 m high sky scraper is a combination of architectural stainless steel and glazing panels. Its structure combines reinforced concrete and structural steel, with deep piles and a slip-formed concrete core.*

**Client:** *The Sport City Project Committee*

**Construction period:** *April 2005 - November 2006*

**Main contractor:** *ARGE MIDMAC - Six Construct*

**Supplier:** *VSL Middel East*

**Scope of supply:** *44 pcs. thread bars SAS 835/1035 Ø 75 mm,  $l \geq 13$  m with a post-tensioning force of 3,200 kN each inclusive all required accessories with nine ring-shaped arranged special slabs of more than 2,5 tons each and 300 mm thickness*

### **Application:**

*At the elevation of 260 m above ground level, this post-tensioning system is required for the three-dimensional alignment of the 60 m high cantilever steel construction in form of a half-open tulip. Inside this construction a 30 m high goblet is placed, in which the Olympic flame burned during the Asian Games 2006.*



## Port, Busan, South Korea

**SAS SYSTEMS**

- Project:** Port in Busan, South Korea
- Client:** Joint Venture of Hyundai Develop. Company and Bouygues
- Construction period:** March 2008 - October 2008
- Subcontractor:** TAEAH Construction Company
- Supplier:** VSL Korea
- Scope of supply:** 281 tons thread bars SAS 950/1050 Ø 36 mm, with accessories like couplers, stressing anchorages and fix nuts

### Application:

SAS pre-stressed bars are used as anchors for the lifting devices of the Caissons. The weight of the Caissons is approx. 2,500 tons. Altogether 62 Caissons have to be anchored with SAS pre-stressed bars. In each Caisson 64 pre-stressed bars SAS 950/1050 Ø 36 mm with a length of 7.45 m up to 10.95 m are embedded. The Caissons are filled up with gravel and sand after they were brought to their final position in the offshore area by heavy ship crane. The high bonding characteristics of the SAS pre-stressed bars make the SAS System superior to all conventional bars.



## *Nelson Mandela Bay Stadium, Port Elizabeth, South Africa*

**SAS SYSTEMS**

- Project:** *Nelson Mandela Bay Stadium in Port Elizabeth, South Africa*
- Client:** *Nelson Mandela Bay Metropolitan*
- Construction period:** *March 2007 - June 2009*
- Main contractor:** *Grinaker-LTA / Interbeton bv.*
- Supplier:** *Duraset*
- Scope of supply:** *135 pcs. post-tensioning bars SAS 950/1050 Ø 36 mm, length 3 m, unbonded tendon with anchor plates and dome nuts at both ends of the bars, 315 pcs. SAS 950/1050 post-tensioning bars, Ø 32 mm, length 2.8 m, unbonded tendon with anchor plates and dome nuts at both ends of the bars*

### **Application:**

*The new Nelson Mandela Stadium, for the 2010 soccer world cup in South Africa, has a seating capacity for 45,900 fans. The post-tensioning bars SAS 950/1050 are used for the vertical and horizontal anchoring of the steel roof structure to the concrete elements. The total area of the roof structure is 45,000 m<sup>2</sup>. The anchorage of the bar SAS 950/1050 is realized with anchor plates and dome nuts cast into the concrete elements.*



## National Stadium, Warsaw, Poland

**SAS SYSTEMS**

- Project:** National Stadium in Warsaw, Poland
- Architect:** JSK Architekci Sp. z o.o., GMP International GmbH, SBP GmbH
- Construction period:** 2011 - 2012
- Construction company:** PBG S.A., Alpine Bau GmbH
- Supplier:** ATM Sp. z o.o.
- Scope of supply:** ATM Sp. z o.o. as SAH's Specialist Company for PT-systems in Poland supplied, installed and stressed 692 pcs. of unbounded post-tensioning bar tendons based on thread bars SAS 950/1050 Ø 40 mm in accordance with the European Technical Approval ETA-05/0122

### Application:

Following the design concept of a light and transparent structure, the SAS post-tensioning system ensures the anchorage of the vertical loads of the steel bracings and the roof structure. Opened on the 29th of January 2012 the national Stadium of Warsaw hosted five matches of the European soccer championship 2012 including the grand opening match.



**3G Shiplift, Yangtze River, China**

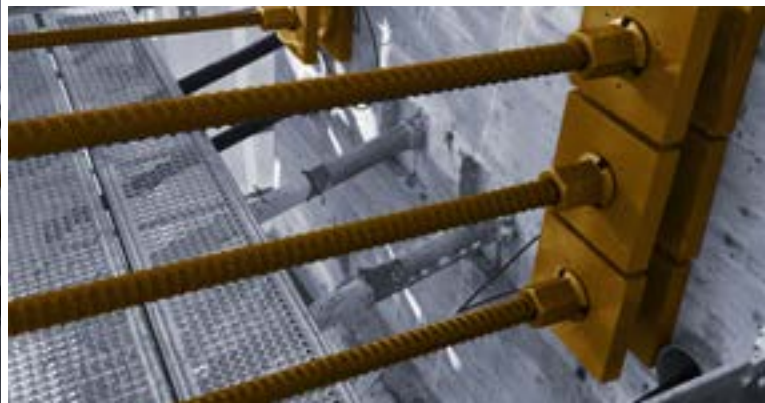
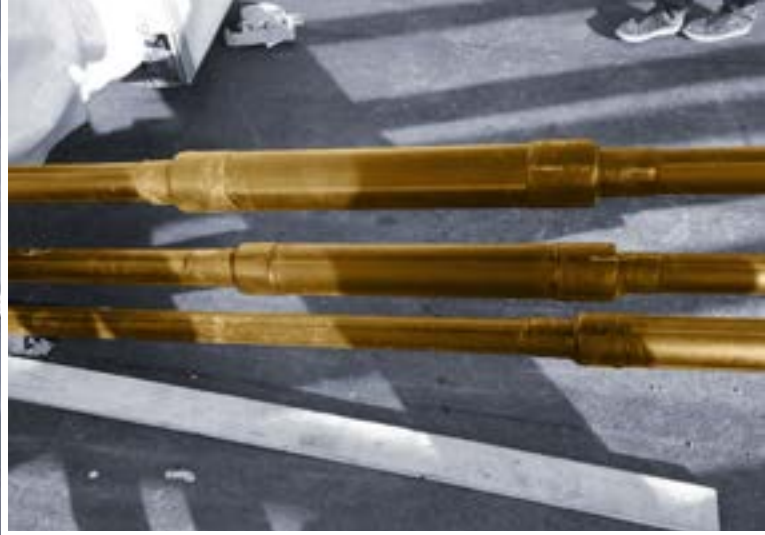
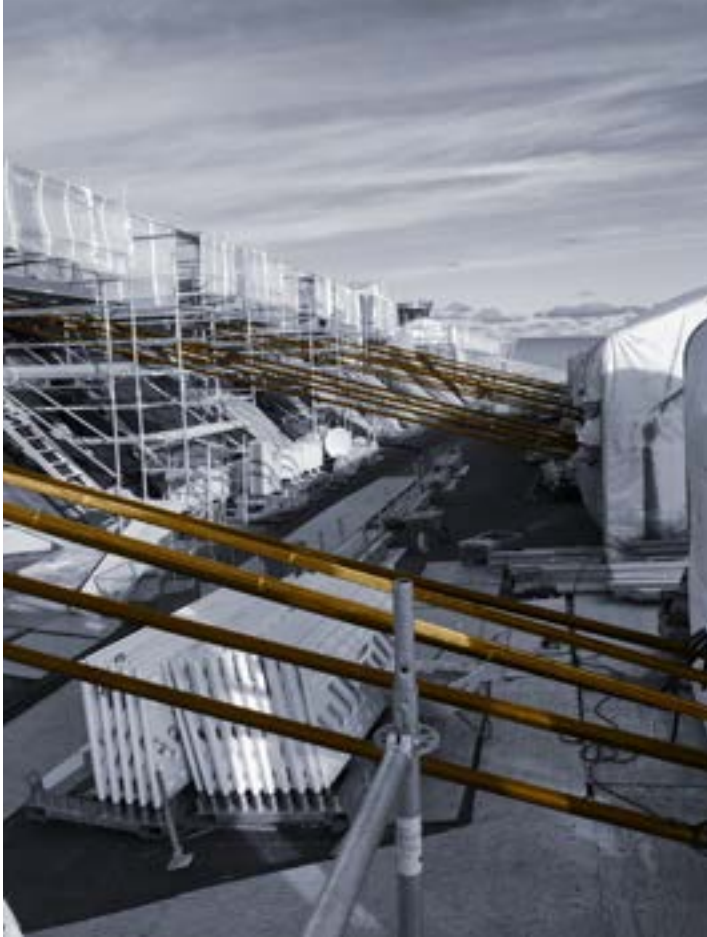
**SAS SYSTEMS**

- Project:** 3G shiplift, Yangtze River, China
- Client:** China Three Gorges Corporation
- Construction period:** 2010 - 2014
- Construction company:** China Gezhouba Group Corporation
- Supplier:** SAS Asia Bar Systems
- Scope of supply:** 708 sets of bar tendons of smooth bars SAS 950/1050 Ø 36 mm, with both end fine thread; unbounded tendons, complete system supplied and consisting of bars, plates, nuts (special anchor nuts and caps designed by SAH for this project)

**Application:**  
 Lifting rail of the world biggest ship lift. A vertical shiplift allows ships to pass the Three Gorges Dam at the Yangtze River. The size of the largest ship chamber is 132 m long, 23 m wide and a depth of 3.5 m, designed for 3000t lifting capacity. The total lifting weight is 34,000 tons with a lifting height of about 113 m. A driven jack screw runs in a steel shaft to lift up the enormous weight and provide a safe emergency stop system. This steel shaft is fixed with the SAS PT-tendons to the concrete member transferring the extreme load. Supervision for installation has been provided by Stahlwerk Annahütte.

Post-tensioning system





## International Airport Terminal 2 B, Helsinki, Finland

**SAS SYSTEMS**

- Project:** *International Airport Terminal 2 B, Helsinki, Finland*
- Construction Period:** *June 2017 to March 2018*
- Client:** *Finavia*
- Designer:** *Pöyry Finland Oy*
- Supplier:** *Naulankanta Oy*
- Scope of supply:** *24 tons SAS 950/1050 Ø40mm and SAS 950/1050 Ø47mm  
Corrosion Protection with shrink sleeve and anchor tube for permanent use.  
The construction includes 5 nodes: Each node consists of:  
4 x 39,2m SAS 950/1050 Ø47mm horizontal  
2 x 38,2m SAS 950/1050 Ø47mm horizontal  
4 x 22,3m SAS 950/1050 Ø40mm horizontal  
4 x 7,2m SAS 950/1050 Ø40mm vertical  
with nuts, coupler, plates with tubes and protection caps*

**Application:**

*The bracing of the roof in the area of terminal 2b – SAS-Post-tensioning system – External bar tendon. Tensile element SAS 950/1050 Ø40mm and SAS 950/1050 Ø47mm thread bars. The Pt-System is intended to be used for the prestressing of structures. External tendon for concrete structures with a tendon path situated outside the cross section of the structure!*



## **Nuclear power plant, Gösgen, Switzerland**

**SAS SYSTEMS**

**Project:** Nuclear power plant in Gösgen, Switzerland, expansion of storage capacity for spent fuel assemblies. Capacity for 1,000 fuel assemblies; designed to withstand airplane crash and earthquake

**Client:** Kernkraftwerk Gösgen-Däniken AG

**Construction period:** October 2004 - February 2008

**Main contractor:** AREVA NP GmbH

**Construction company:** Implenia Bau AG

**Scope of supply:** 1,340 tons thread bars SAS 500/550 Ø 12 - 32 mm with accessories for end anchorages, coupling and turnbuckle splices. SAS thread bars and accessories are delivered bended and preassembled according to structural design requirements

### **Application:**

The thread bars SAS 500/550 are used as reinforcement in the outer shell and in the fuel pool of the spent fuel storage facility. The easy installation and the coarse thread bars SAS 500/550 compensate the high percentage of reinforcing bars in that project. The SAS couplers ensure an easy and place saving installation of the thread bars SAS 500/550 between the individual sections.



## Frankfurt Operatower, Germany

**SAS SYSTEMS**

**Project:** Scyscraper Operatower in Frankfurt on the Main, Germany

**Client:** Opernplatz Property Holdings GmbH & Co. KG

**Construction period:** January 2007 - December 2009

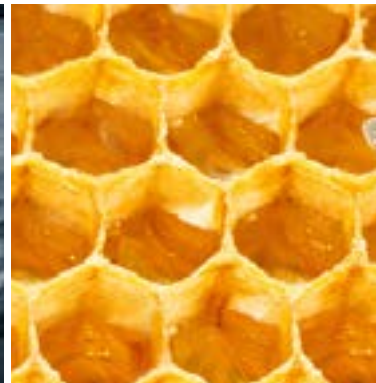
**Main contractor:** Ed. Züblin AG

**Owner:** Tishman Speyer

**Scope of supply:** 320 tons thread bars SAS 670/800 Ø 30 - 75 mm,  
3,700 pcs. contact couplers

### Application:

The high-strength thread bars SAS 670/800 and contact couplers are used for reinforcing the columns of a high-rise building (total height of the building ~170 m) in Germany for the first time. The total longitudinal reinforcement of the high load capacity and edge columns is designed with the high-strength thread bars SAS 670/800. The ratio of reinforcement is up to 13 %. This high ratio of reinforcement at no congestion of steel in the columns is possible due to the rebar diameter of up to 75 mm. Mechanical splices of SAS thread bars by contact couplers allow the transferring of high compressive forces.



## ICE high speed railway line, Germany

**SAS SYSTEMS**

- Project:** Slab track system Bögl, ICE high speed railway line, Nuremberg-Ingolstadt & Erfurt-Ilmenau
- Client:** Deutsche Bahn AG
- Construction period:** April 2003 - April 2004 (Nürnberg-Ingolstadt)  
July 2011 - August 2012 (Erfurt-Ilmenau)
- Total distance:** 128 km
- Main contractor:** Max Bögl
- Scope of supply:** 1,865 tons thread bars SAS 500/550 Ø 20 mm with fix length of 6.44 m each

### Application:

The thread bars SAS 500/550 are used for coupling the prefabricated components of fixed trackway system, manufactured on the production sites of the precasting plants of Max Bögl. Each precast slabs consist of six bars. The fixed trackway elements with a nominal length of 6.5 m were connected and stressed via exposed ends of thread bars together with turnbuckles and dome nuts. In fact of force-locked connections between the precast slabs with thread bars dynamic loads caused by high-speed trains can be absorbed safely.



## ***New World Trade Center, New York, USA***

**SAS SYSTEMS**

- Project:** *New World Trade Center in Manhattan - New York, USA*
- Construction Period:** *2008 - 2015 (expected)*
- Client:** *Silverstein Properties*
- Main contractor:** *Halmar International, Turner Constructions, Tishman Constructions*
- Scope of supply:** *6,200 tons high strength reinforcement bars SAS 670/800 Ø 43 and 75 mm with plates, lock nuts and couplers, 450 tons post-tensioning bars SAS 835/1035 Ø 75 mm as DCP-rockanchors with anchor heads and coupling systems*

### **Application:**

*As part of the rebuilding effort for the WTC site a memorial and four new towers (1 WTC to 4 WTC) were built. The master plan architect for the rebuilding was Daniel Libeskind. One world trade center (former Freedom Tower) will reach approx. 540 m and will be the highest building of New York when it's finished. SAS steel was used for foundation work (DCP-anchors and caisson-piles) and for the superstructure (columns and shear walls) of the new towers. Common reinforcement was replaced by SAS 670/800 for cost reduction reasons. Reinforcement cages were used to improve the workflow for reinforced concrete columns. The reinforcement for the composite columns was assembled bar by bar. The easy, fast and hence economic assembling of high strength thread bars satisfied the reinforcement and construction company as well as the owner of the building.*



**Lotte Tower, Seoul, Korea**

**SAS SYSTEMS**

**Project:** Lotte Tower in Seoul, Korea

**Construction Period:** 2010 - 2015

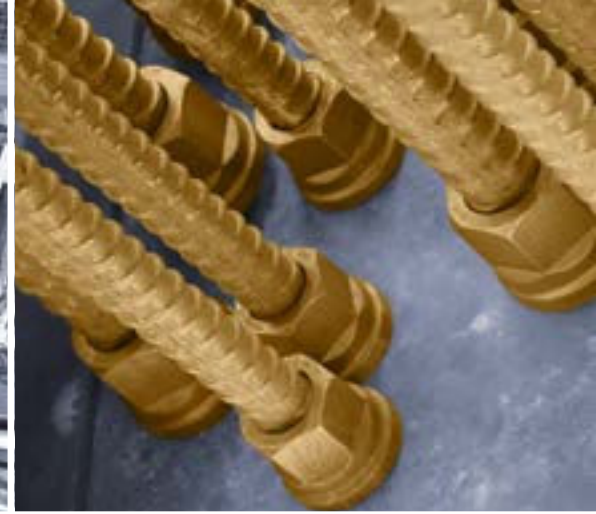
**Client:** Lotte Engineering & Construction, Seoul, Korea

**Supplier:** SAS Asia Bar Systems

**Scope of supply:** 600 tons thread bars SAS 600/680 Ø 50 mm for high strength reinforcement, 8,140 couplers as well as 488 special couplers to connect conventional reinforcing bars to thread bars SAS 600/680

**Application:**

The Lotte Tower, with a height of 555 m and housing the highest observation deck at a height of 497.6 m, is at present the second highest building in Asia. It has 123 floors above ground, 6 floors below ground for parking, floors 1-6 house shops, floors 7-60 offices, floors 61-85 apartments, floors 86-119 a luxury hotel, floors 120-123 including observation deck are designated for public use. The SAS thread bars have been installed in the vertical and longitudinal reinforcement within the 8 mega columns. The thread bars SAS 600 /680 have been developed and approved especially for this project. The Doka Group also supplies the formwork system both for the mega columns and core structure. SAS form ties are used for this as well.



**ITER, Saint-Paul-lès-Durance, southern France**

**SAS SYSTEMS**

**Project:** *ITER - International Thermonuclear Experimental Reactor in Saint-Paul-lès-Durance, southern France*

**Construction Period:** *2015 - 2025 (expected)*

**Client:** *Groupement VFR : VINCI Construction / FERROVIAL / RAZEL BEC*

**Main constructor:** *ITER ORGANIZATION*

**Scope of supply:**  
*SAS 500/550-50 length 6900 mm 360 pieces*  
*SAS 500/550-50 length 6000 mm 40 pieces*  
*SAS 500/550-40 length 5800 mm 32 pieces*  
*SAS 500/550-40 length 6670 mm 288 pieces*  
*T2163/50 920 pieces*  
*T2163/40 234 pieces*

**Supplier:** *AdC - Accessoires de Construction*

**Application:**  
*ITER will be the first fusion facility. The tokamak is an experimental machine designed to harness the energy of fusion. ITER will be the world's largest tokamak. One-meter thick radial walls will connect the massive ITER bioshield to the concrete tokamak crown, which will support the combined mass of the cryostat, the vacuum vessel, the magnet system and the thermal shield. The spokes are reinforced with numbers of SAS 500 bars.*

Reinforcing coupling system



## *Daftha-Shis Tunnel , Dubai, UAE*

**SAS SYSTEMS**

- Project:** *Daftha-Shis Road & Tunnel in Dubai, UAE*
- Client:** *Government of Sharjah, Directorate of Public Works*
- Construction period:** *January 2006 - August 2010*
- Main contractor:** *General Mechanic Company*
- Supplier:** *VSL Middle East LLC*
- Scope of supply:** **Portal:** 400 pcs. thread bars SAS 670/800 Ø 18 mm, L = 6.15 m, domed washer 30°, bull nose nuts 30°,  
**Tunnel:** 25,000 pcs. thread bars SAS 500/550 Ø 25 mm, L = 4.15 m, domed washer 30°, dome nuts 30°, resin cartridges

**Application:**

SAS thread bars are used as rock nails for the portal face and as rock bolts for the inner tunnel layer. The SAS thread bars and accessories for the portal are hot-dip galvanized. The tunnel exists of two tunnel sections with a length of 1.250 km and 1.275 km. During installation the rock bolts are stressed up to 50 kN. The bond length of the cartridges is 3 m.





## **Potash-mine, Werra-Unterebreizbach, Germany**

**SAS SYSTEMS**

- Project:** *Potash-mine in Werra-Unterebreizbach, Germany.*
- Client:** *K+S Kali GmbH, Kassel, Germany*
- Delivery period:** *Since 1997*
- Supplier:** *Stahlwerk Annahütte*
- Scope of supply:** *SAH supplies yearly an amount of 450,000 pcs. of SAS thread bars for the expansion shell anchorage system. The thread bars SAS 450/700 Ø 16 mm, ensure a yield load of 93 kN and an ultimate load of 145 kN*

### **Application:**

*Thread bars SAS 450/700 for mining applications have to fulfil special criteria and requirements for mining applications, given by national and international standards. Therefore, SAS thread bars have to be made of natural hard and high-ductile steel qualities due to the required working capacity. Concerning to those properties, together with an easy and fast installation-procedure, SAS thread bars are perfect to use for an expansion shell anchorage system to stabilize and secure the excavations of the potash-mine.*



## **Power plant Realp II, Switzerland**

**SAS SYSTEMS**

- Project:** *Power plant Realp II, Switzerland*
- Client:** *Elektrizitätswerk Ursern*
- Delivery period:** *2015 - 2016*
- Supplier:** *Stahlwerk Annahütte*
- Scope of supply:** *RG Bolt SAS 670/800 Ø22, length 3,00 m, black bars*

### **Application:**

*The hydropower plant Realp II in Urserental within the Gotthard Massif in Switzerland is expected to reach a planned annual production of 9.5 GWh. The consortium Strabag AG / Gasser Felstechnik AG commissioned by the electricity company Ursern hydropower to build the new plant Realp II. During the excavation of the access tunnel the SAS RG Bolt was used to secure blasting in the massive two-mica gneiss. The access tunnel of 11,60 m<sup>2</sup> could be performed entirely in the driving class 1. The immediately effective anchoring work was ensured by means of an expansion anchor, the permanent support action by subsequent cement grouting. The enormous advantage of SAS RG Bolt system laid in the ability to combine immediate anchorage with permanent rock support.*



## Ventilation tunnel Bleßberg, Thuringia, Germany

**SAS SYSTEMS**

- Project:** Ventilation tunnel Bleßberg, Thuringia (Germany)
- Client:** Deutsche Bahn AG
- Construction Period:** 2016 - 2017
- Main Contractor:** Ed. Züblin AG Direktion IU Tunnelbau
- Scope of supply SAH:** High strength SN Anchors SAS 900/1050 SN Ø18,6, length 3.00 m

### **Application:**

The Bleßberg tunnel is the longest tunnel on the new ICE high-speed line Nuremberg – Erfurt. The Bleßberg tunnel crosses the main ridge of the Thuringia forest low mountain range. From a geological point of view, the Bleßberg tunnel is located in areas with quartzite slate, graywacke and Frauenbachquarzit layers. The new high-strength SAS SN anchors secure the tunnel work of the Bleßberg ventilation tunnel which combines drilling and blasting with excavators. The ventilation tunnel is one of the last phases of mining work necessary to complete the new high-speed line. The new high strength SN anchors were selected due to their ease of handling resulting from a 44% weight reduction compared to conventional SN anchors. Additionally, the coarse threads on the high strength SN anchors enabled rough handling onsite, and the lengths could be fitted to the as-built condition because the continuous threads allowed cutting of the SN at any location.



## Trimbergtunnel, Highway A44, Hesse, Germany

**SAS SYSTEMS**

<b>Project:</b>	<i>Trimbergtunnel, Highway A44, Hesse, Germany</i>
<b>Construction Period:</b>	<i>2018 - 2019</i>
<b>Owner:</b>	<i>Federal Republic of Germany, represented by DEGES</i>
<b>Main contractor:</b>	<i>ARGE Tunnel Trimberg, Hochtief Infrastructure GmbH und Ed. Züblin AG, Direktion im Tunnelbau</i>
<b>Scope of supply:</b>	<i>High strength SN Anchors SAS 900/1050 SN Ø 18,6, length 4.0m and 6.0m</i>

### **Application:**

*The Trimberg tunnel is part of construction phase 9 and part of the new construction of BAB 44. As a cross-connection of the A7 motorway near Kassel and the A4 near Herleshausen, the A44 with the Trimberg tunnel relieves the suburban road network from trans-regional transit traffic and connects the region to the nationwide trunk road network. The Trimberg tunnel consists of two tubes of 600m - each of which 440m are driven by mining in cyclic method. The tunneling intersects the new red sandstone the so called Bernburg sequence and is executed in shotcrete construction by excavator driving and blasting. To secure the excavation section while the new high-strength SAS SN anchors are used.*

*Among the advantages of the high-strength SAS SN anchors, in addition to the possibility of rough handling on the construction site and their length flexibility due to the endless coarse thread, is, above all, a 44 % weight reduction compared to conventional products, which allow manual setting even of longer installation lengths. Especially in connection with the physical workload, the new development of the Stahlwerk Annahütte steelworks contributes to significant improvements.*



## Soukaan Station, Länsimetro Helsinki, Finland

**SAS SYSTEMS**














<b>Project:</b>	<i>Soukaan Station, Länsimetro Helsinki, Finland</i>	
<b>Client:</b>	<i>Skanska Oy</i>	
<b>Delivery period:</b>	<i>March 2016</i>	
<b>Supplier:</b>	<i>Naulankanta Oy</i>	
<b>Scope of supply:</b>	<i>RG Bolt SAS 650/800 Ø22m;</i> 300 pcs. L = 3,00 m <i>hot dip galvanized acc. DIN EN 1461 + coating acc. DIN EN 12944</i> 200 pcs. L = 4,00 m <i>hot dip galvanized acc. DIN EN 1461 + coating acc. DIN EN 12944</i> 150 pcs. L = 5,00 m <i>hot dip galvanized acc. DIN EN 1461 + coating acc. DIN EN 12944</i> 300 pcs. L = 6,00 m <i>hot dip galvanized acc. DIN EN 1461 + coating acc. DIN EN 12944</i>	

### **Application:**

*Länsimetro is an extension to the Helsinki Metro system. The grand opening for the long awaited extension was held on 18 November 2017. Länsimetro extends the system's two lines, M1 and M2, from central Helsinki, Finland, to the neighbouring city of Espoo. Final approval for a 13.5-kilometer route was granted on 4 April 2007, and the construction began in November 2009. In February 2014, rock blasting was complete, and the fitting out of the tunnels and construction of the stations was started. SAH delivered for the Station Soukaan – 950 pcs. RG-Bolts in different length for the temporary rock support during excavation and later on grouted as permanent rock support.*

# SAS Gewindestäbe | SAS thread bar

Streckgrenze / Zugfestigkeit | *yield stress / ultimate stress*  
Anwendungsbereiche | *areas of application*

	Nenn- $\varnothing$ <i>nom. <math>\varnothing</math></i>	Strecklast <i>yield load</i>	Bruchlast <i>ultimate load</i>	Fläche <i>cross section area</i>	Gewicht <i>weight</i>		Dehnung <i>elongation</i>	
	[mm]	[kN]	[kN]	[mm <sup>2</sup> ]	[m/to]	[kg/m]	A <sub>gt</sub> [%]	A <sub>10</sub> [%]
<b>SAS 500 / 550 – grade 75</b>								
 Bewehrungstechnik   <i>reinforcing systems</i>	12	57	62	113	1123,6	0,89	6	10
	14	77	85	154	826,4	1,21		
	16	100	110	201	632,9	1,58		
	20	160	175	314	404,9	2,47		
	25	245	270	491	259,7	3,85		
	28	310	340	616	207,0	4,83		
	32	405	440	804	158,5	6,31		
	36	510	560	1020	125,2	7,99		
	40	630	690	1260	101,3	9,87		
	43	726	799	1452	87,7	11,40		
 Geotechnik   <i>geotechnical systems</i>	50	980	1080	1960	64,9	15,40		
	57,5	1441	1818	2597	49,1	20,38	5	10
SAS 555 / 700 – grade 80	63,5	1760	2215	3167	40,2	24,86	5	---
SAS 500 / 550 – grade 75	75	2209	2430	4418	28,8	34,68	5	---
<i>Alternativ SAS 550 erhältlich   alternative SAS 550 grade 75 available</i>								
<b>SAS 450 / 700 – grade 60</b>								
 Bergbau   <i>mining</i>	16	93	145	207	617,3	1,62		(A <sub>3</sub> ) 15
	25	220	345	491	259,7	3,85		(A <sub>3</sub> ) 20
<b>SAS 650 / 800 – grade 90</b>								
 Bergbau   <i>mining</i>	22	247	304	380	335,6	2,98		(A <sub>3</sub> ) 18
	25	319	393	491	259,7	3,85		
	28	400	493	616	207,0	4,83		
	30	460	565	707	180,2	5,55		
<b>SAS 670 / 800 – grade 97</b>								
 Geotechnik   <i>geotechnical systems</i>	18	170	204	254	500,0	2,00	5	10
	22	255	304	380	335,6	2,98		
	25	329	393	491	259,7	3,85		
	28	413	493	616	207,0	4,83		
	30	474	565	707	180,2	5,55		
 Ankertechnik   <i>tunneling &amp; mining</i>	35	645	770	962	132,5	7,55		
	43	973	1162	1452	87,7	11,40		
	50	1315	1570	1963	64,9	15,40		
 Hochfeste Bewehrung   <i>high-strength reinforcement</i>	57,5	1740	2077	2597	49,1	20,38		---
	63,5	2122	2534	3167	40,2	24,86		---
	75	2960	3535	4418	28,8	34,68		---
<b>SAS 950 / 1050 – grade 150</b>								
 Spanntechnik   <i>post-tensioning systems</i>	18	230	255	241	510,2	1,96	5	7
	26,5	525	580	551	223,2	4,48		
	32	760	845	804	153,1	6,53		
	36	960	1070	1020	120,9	8,27		
 Geotechnik   <i>geotechnical systems</i>	40	1190	1320	1257	97,9	10,21		
	47	1650	1820	1735	70,9	14,10		
<b>SAS 835 / 1035 – grade 150</b>								
 Geotechnik   <i>geotechnical systems</i>	57	2155	2671	2581	47,7	20,95	4	---
	65	2780	3447	3331	36,9	27,10		
	75	3690	4572	4418	27,9	35,90		
<b>SAS 900 / 1100 FA – grade 160 FA</b>								
 Schalungstechnik   <i>formwork ties</i>	15	159	195	177	694,4	1,44	3	7
	20	283	345	314	390,6	2,56		
	26,5	495	606	551	223,2	4,48		
<b>SAS 900 / 1050 FC – grade 150 FC</b>								
 Schalungstechnik   <i>formwork ties</i>	15	159	186	177	694,4	1,44	3	7
	20	283	330	314	390,6	2,56		
SAS 950 / 1050 E – grade 150	26,5	525	580	551	223,2	4,48	5	7
<b>SAS 750 / 875 FS – kaltgerollt   cold rolled – grade 120 FS</b>								
 Schalungstechnik   <i>formwork ties</i>	12,5	90	120	132,5	961,5	1,04	2	5,5
	15	142	165	189	675,7	1,48		
	20	245	285	326	390,6	2,56		

Zubehör für alle Abmessungen und Anwendungen lieferbar | *accessories for all dimensions and applications available*