# Integrated lifting and handling solutions

FREYSSINET

# The Freyssinet Group

**Freyssinet brings together an unrivalled set of skills in the specialist civil engineering sector. It implements solutions with high added value in two major fields: construction and repair**.

With its 5,000 employees, Freyssinet is involved in numerous major projects on five continents, making it the world leader in its specialist areas of: pre-stressing; construction methods; cable-stayed structures; structural accessories; repairs, and structural reinforcement and maintenance.

Freyssinet is highly involved in sustainable development issues and has set up a number of initiatives, particularly to reduce the environmental impact of its projects and enhance its social responsibility policy.

Freyssinet is a subsidiary of the Soletanche Freyssinet group, a world leader in the soils, structures and nuclear sectors.

*Cover photos:*
*Lifting complete spans in Ulyanovsk (Russia)*

**Freyssinet and its specialist subsidiary Hebetec Engineering combine their expertise and know-how to offer their customers integrated solutions in the field of lifting and handling of structures, including designing installation methods, supplying hydraulic equipment, designing temporary structures and carrying out specialist works.**

## Our expertise

With over 30 years' experience in lifting and handling not only the most imposing structures in the field of civil engineering but also in the construction and industrial sectors, Freyssinet and Hebetec Engineering have taken part in numerous substantial design-and-build projects. They have acquired world-renowned expertise and know-how.

## Freyssinet, your project partner

Lifting and handling are complex operations that often influence the successful completion of a project. Our teams support our customers throughout their projects, by being generally involved from the design phase, in order to assess their objectives and to produce optimum solutions that fully meet their specifications in terms of structures, phasing of works, budget and lead times.

## Proven technologies

Moving a structure demands absolute control over the stresses induced in the structure from the start to the end of the operation. Freyssinet and Hebetec Engineering have therefore developed a range of specific lifting and handling equipment, with real-time control and precision enabling the most stringent requirements to be met in terms of managing reactions and movements at the jacking points.

# Contents



## Risk management

In accordance with Freyssinet group safety policy, every lifting and moving process is subjected to a HAZID (HAZard IDentification study)/HAZOP (HAZard and OPerability study) type assessment involving the project methods engineers and the specialist team using the equipment.

## A comprehensive range of exclusive technologies

- **Strand lifting**
  - Hebetec strand jack system
- **Lifting and jacking structures**
  - MegaSteel® profile and tower systems
- **Structure handling**
  - Computer-aided precision jacking: LAO® system;
  - Incremental launching, sliding and rotation on Freyssinet bearings using long-stroke jacks;
  - Air Pad Sliding (APS).
- **Structure sliding**
  - Autoripage® using Hebetec strand jack system;
  - Autofonçage® using Hebetec strand jack system;
  - Air Pad Sliding (APS) using Hebetec strand jack system or a push-pull jack system.


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## An integrated service, from engineering studies to implementation

- Feasibility studies and operation sequencing;
- Detailed design of lifting and moving methods;
- Checks on permanent structures during stages of works (optional);
- Design of **MegaSteel®** temporary structures;
- Supply of specialist equipment;
- Supply and installation of **MegaSteel®** temporary structures;
- Performance of lifting and handling operations.

*1 - Lifting the Duret water tower (France)*
*2 - Lifting the roof of Salzburg stadium (Austria)*
*3 - Bridge sliding in Boissy-Saint-Léger (France)*


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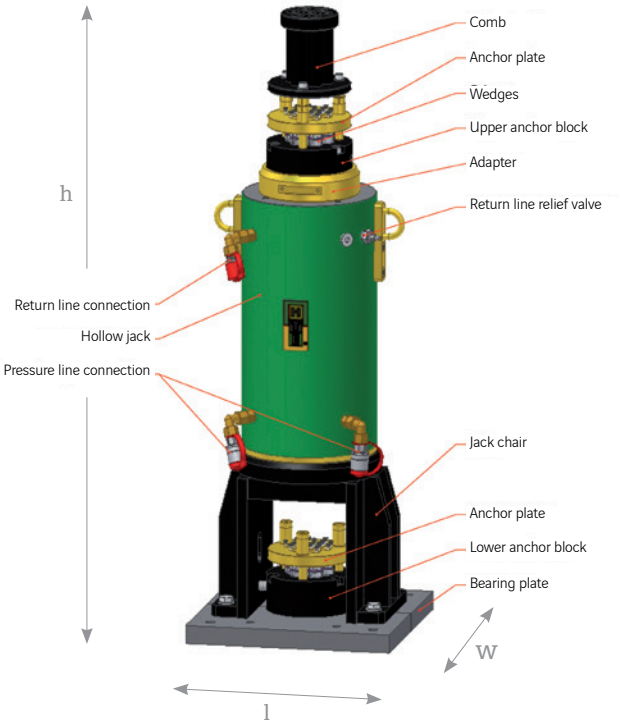
# STRAND LIFTING

## How a Hebetec strand jack works




**Specifications for a lifting strand:**
*As per EN 10138-1 & 3*

*Nominal diameter:* **15.2-15.7 mm**
*Transverse section:* **140-150 mm²**
*Tensile strength:* **1,860 MPa**
*Nominal breaking load:* **260-279 kN**
*Modulus of elasticity:* **195 GPa**

**Strand lifting can be used to lift or lower almost any load, regardless of its height. It is a modular system that consists of setting up a jack and a lifting cable at as many points as necessary. All of the jacks are then operated and monitored simultaneously.**

## Strand lifting cables

Each cable is made up of a bundle of parallel high-strength steel strands, varying in number in line with the lifting capacity sought. A bundle may comprise a maximum of 55 strands and its maximum working load is calculated with a safety factor of 2.5. Cables of different sizes will often be used for a single lifting operation, allowing for the differences in stiffness of each cable.

## Hebetec cable lifting jacks

The bundle of strands passes through the hollow jack, which is anchored at two different levels. During lifting, the two anchors are placed under load one after the other: when the jack extends only the upper anchor is locked, pulling the cable, and when it retracts only the lower anchor is locked, holding the load.
Because of their critical role in the success of the lifting operation, the jacks are designed and manufactured by Hebetec. This robust equipment has proven its durability and reliability during operations conducted in the course of numerous projects.

## Hebetec jack specifications

| Designation | Lifting K = 2.5 (kN) | Stroke (mm) | Weight (kg) | Dimensions (mm) (l, w, h) |
|---|---|---|---|---|
| **H-10** | 100 | 280 | 65 | 250 x 250 x 1,054 |
| **H-40** | 400 | 280 | 160 | 300 x 300 x 1,122 |
| **H-70** | 700 | 280 | 290 | 400 x 400 x 1,194 |
| **H-140** | 1400 | 280 | 520 | 400 x 400 x 1,193 |
| **H-200** | 2,000 | 280 | 770 | 500 x 500 x 1,330 |
| **H-400** | 4,000 | 280 | 1,800 | 700 x 700 x 1,503 |
| **H-600** | 6,000 | 350 | 3,850 | 800 x 800 x 1,745 |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## Hydraulic power units

In order to complete lifting operations within a period that is often just a few hours, the lifting jacks are powered by very high capacity hydraulic power units. The heaviest loads are therefore generally lifted at a rate of between 5 and 10 m/h, whereas lighter loads are lifted at rates of up to 80 m/h.

## Control systems

All of the hydraulic power units are controlled from a control centre that manages all of the lifting parameters: the pressure and stroke of each jack and the movements of the structure at critical points. As an option, surveying equipment can be used for long lifting strokes and wherever high geometric precision is required. Video cameras are frequently used for complex sequences.


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*1 - Lifting drains in Malmö (Sweden)*
*2 - Control centre*
*3 - Lifting the Shenzhen Bridge in Hong Kong (China)*
*4 - Lifting point equipment in Frankfurt (Germany)*

# LIFTING AND JACKING STRUCTURES

1

**MegaSteel® is a system of profiles and accessories used to build temporary high-capacity columns or lattice towers to a very great height. It is often an essential addition to the majority of lifting and jacking operations.**

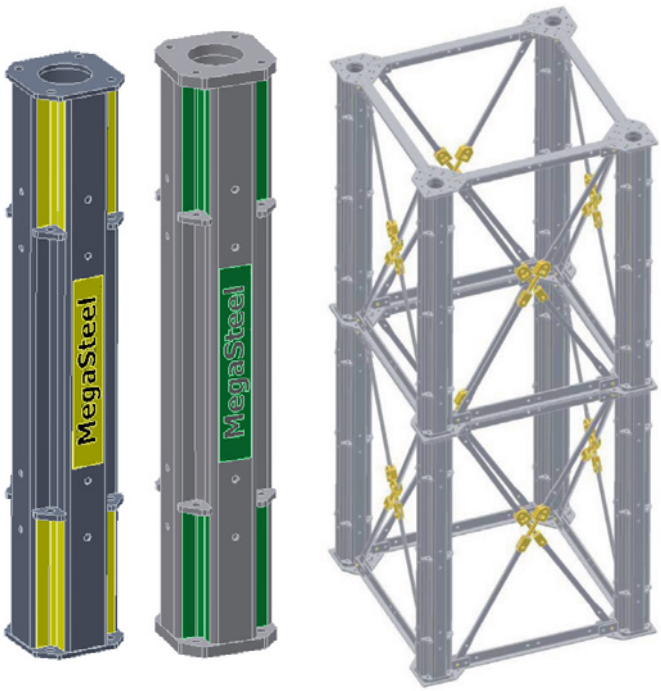
Very tall columns are by their very nature liable to buckle when subjected to vertical compression, and will do so even more quickly if their column loading is off-centre due to deviations from straightness, vertical alignment and the effects of horizontal loads (including the effects of the wind on a moving load). Under no circumstances must they constitute a weak point during lifting or jacking operations.

## Guaranteed turnkey service

- **Robust design** based on a fully modular system with towers made up of identical stages and used in predefined and controlled configurations;
- **High-quality manufacturing** designed to reduce internal stresses and geometric defects, thus obtaining precision parts;
- **Reliable installation** based on simple, robust assemblies and tried and tested ground support accessories;
- **Structural checking** that takes into account of column fastening systems and stabilising stay cables at several levels and in different directions;
- **Tower loading controlled** using standardised transfer headers.

The MegaSteel® system has been specially designed for fast erection and tear-down. Because it is modular, it can be transported without any particular restrictions.

Using standard, robust equipment, Freyssinet's MegaSteel® offering guarantees the highest level of safety.

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| MegaSteel® designations | Types | Section lengths (mm) | Reference loads (kN) * | Usual heights (m) |
|---|---|---|---|---|
| MS Series | Columns | 90 to 2,700 | 1,000 | 20 |
| | Lattice towers | 2,700 | 4,000 | 40 |
| MSt Series | Columns | 90 to 2,700 | 2,000 | 20 |
| | Lattice towers cable-stayed at top | 2,700 | 6,000 | 40 |
| | Lattice towers cable-stayed at 2 levels | 2,700 | 6,000 | 80 |

*(*) The reference load is shown for a buckling length of 3 m for columns and 40 m for towers*


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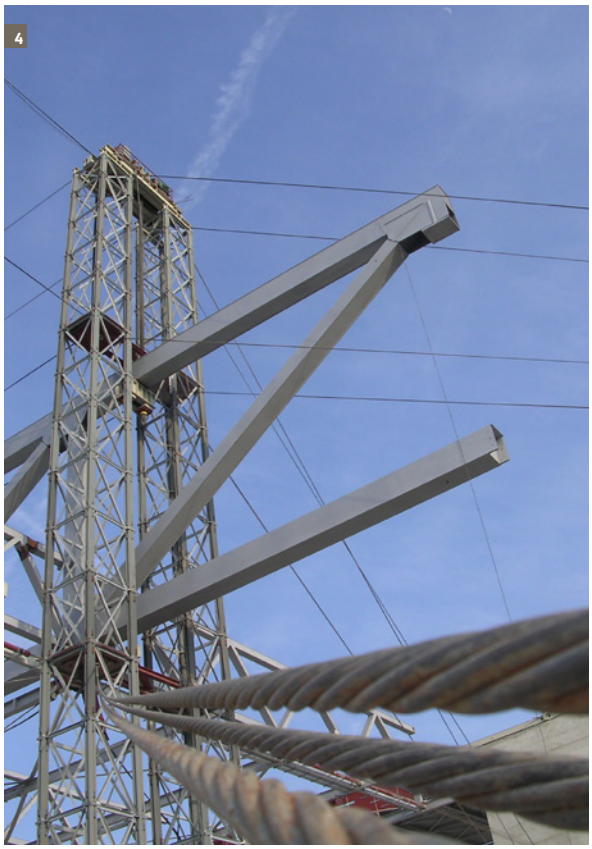
*1 - Stay cable system for a lattice tower*
*2 - MegaSteel® MS, MSt and Lattice Module profiles*
*3, 4 and 5 - Lifting the roof of an Airbus A380 hangar in Frankfurt (Germany)*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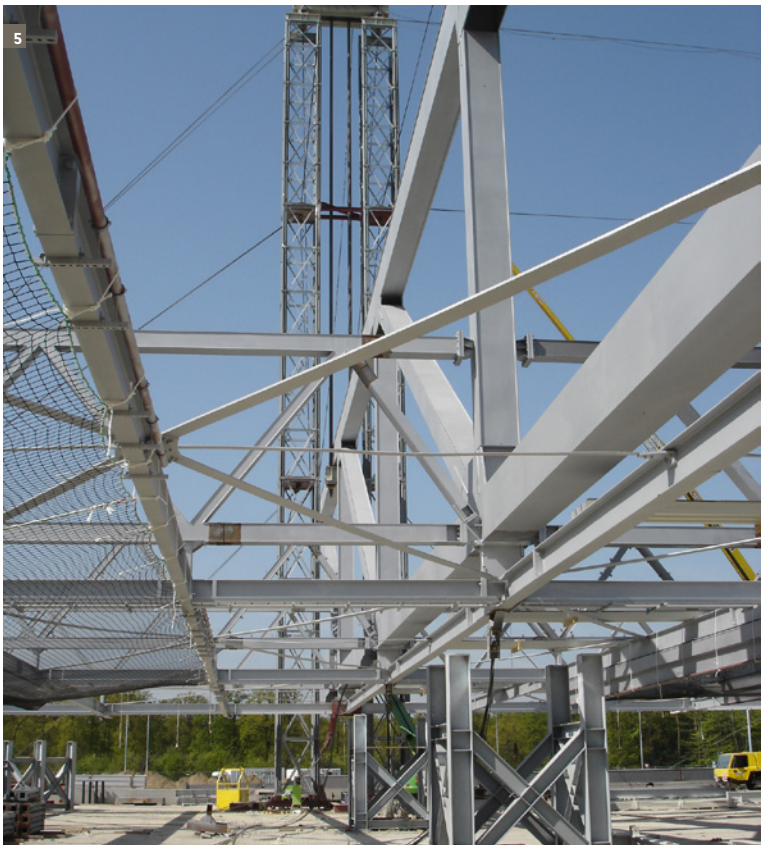
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# STRUCTURE HANDLING

**Freyssinet jacking, incremental launching, sliding and rotation systems are ideal for moving new structures built near their final location or moving old ones to a dismantling area.**

## LAO® precision jacking

Whenever a rigid structure needs to be lifted at several points using hydraulic jacks and in order to control the stresses induced in this structure, real-time precision control is required to monitor differences in stroke between lifting jacks. The LAO® system automatically coordinates all jacks simultaneously by analysing the lifting parameters (jack pressure and stroke, movements in the structure), while at the same time ensuring accuracy of the order of a few tenths of a millimetre. As a mobile unit, it is quick and easy to set up. The LAO® system enables all data to be recorded during the jacking operation.

## Incremental launching, sliding and rotating of structures

Moving operations combine the use of hydraulic jacks and sliding bearings which vary depending on the material making up the structure (steel or concrete), the loads to be moved and the movements to be carried out.

Due to the lack of precision in the actual reactions applied to them (load distribution, friction cœfficient), the jacks and sliding bearings are designed to be very rugged.

- Push-pull jacks: 200 t max.
- Strand lifting jacks used for hauling: 1,000 t max.
- Banded elastomeric bearings with sliding interface
- Steel roller bearings
- Mechanical pot bearings allowing rotation under load

*1 - LAO®/jacking control centre for bearing replacement*
*2 - Transverse sliding using push-pull jacks in Treguey (France)*
*3 - Transverse sliding of the old and new Orgon bridges (France)*
*4 - Sliding on APS modules in Dijon (France)*
*5 - Rotating the Allonne bridge (France)*

## APS sliding bearing

The APS sliding bearing is a patented device that enables heavy structures to be moved on air pads, ensuring that the friction cœfficient is kept very low (less than 1%), and allowing for light moving equipment to be used.

APS bearings are generally laid out along a sliding path equipped with side guides and which enables sliding speeds of 20 to 80 m/h to be reached.
Every APS system is equipped with a high-capacity hydraulic jack which is used to transfer its load before and after the movement, or to adjust reaction at any time during the move. Multidirectional lifting and sliding are thus combined in one and the same compact system.

| Designation | Plan dimensions (mm) | Vertical load capacity (kN) | Height in retracted position (mm) | Stroke (mm) |
|---|---|---|---|---|
| **M 250** | 1,125 x 1,125 | 2,500 | 868 | 330 |
| **M 385** | 1,125 x 1,125 | 3,850 | 973 | 400 |

The dedicated hydraulic power units and the control centre enable the hydraulic jacks for several APS sliding bearings to be controlled simultaneously.


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# STRUCTURE SLIDING

**Freyssinet has developed three different technologies for sliding complete structures from their fabrication area to their installation site. They consist of prefabricating a structure next to the railway track or the road and quickly transferring it to its final position during a brief period of track closure (approx. two days) in order to minimise traffic disruption.**

## Autoripage®

This technique consists of completely clearing the ground and sliding the structure on bentonite grout using Hebetec 1,000-tonne jacks. Once the sliding is complete, backfilling takes place in order to re-open the route to traffic.

## Autofonçage®

This technique consists of partly clearing the ground and then sliding and driving the structure forwards into the infill as the excavation work progresses, using the same equipment as for the Autoripage® technique. No backfilling is required as the volume of earth excavated is identical to the volume of the structure.

## Air Pad Sliding

This technique is identical to the Autoripage® technique, with air pad sliding bearings (APS modules) in lieu of bentonite.
It consists of completely clearing the ground, installing skidways, then moving the structure on APS modules, which have a friction cœfficient of less than 1%. Once the sliding is complete, backfilling takes place in order to re-open the route to traffic.

### The stages in putting a structure in place (Étampes - France)

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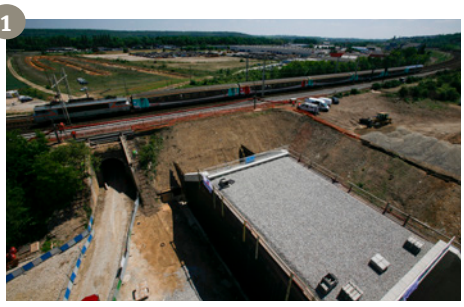

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*1 - Prefabricating the structure next to the track and positioning the driving nose*
*2 - Start of excavation on Friday at the end of the day*
*3 - Excavation and sliding*

# Close-up

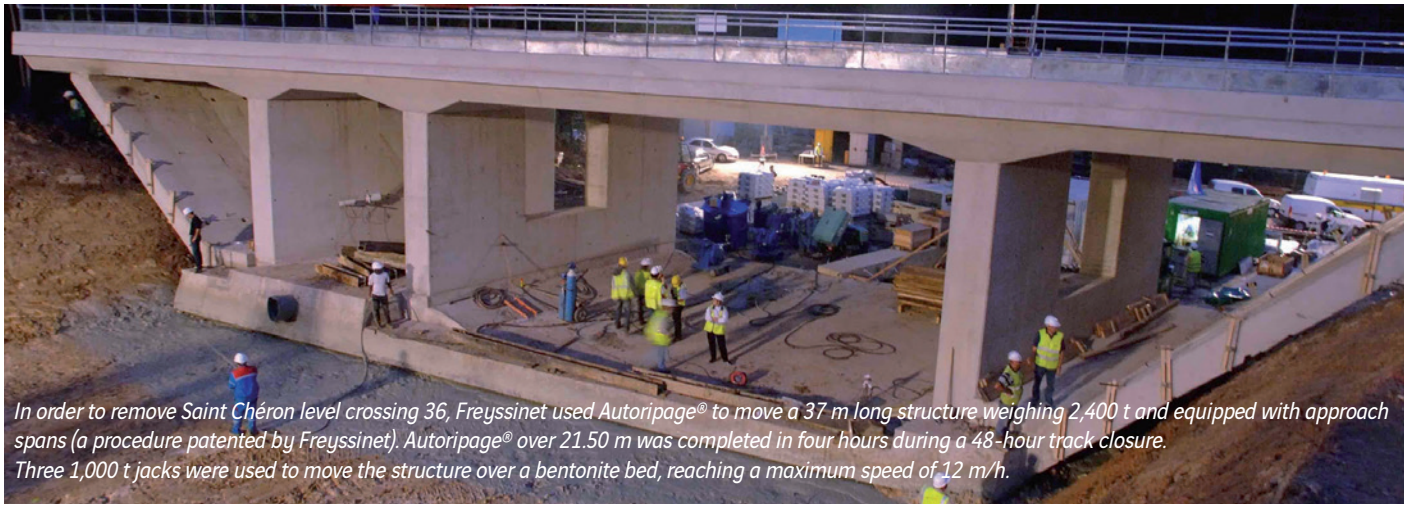
## Autoripage® in Micheville (Luxembourg)

*World record*

*Freyssinet used Autoripage® to slide a 60 m long structure weighing 21,000 t in 14 hours during a 72-hour track closure. Seven 1,000 t jacks and twelve 500 t jacks were used to move the structure over a bentonite bed, reaching a maximum speed of 6.2 m/h.*

(photo, previous page)

## Autoripage® of a rail bridge in Saint-Chéron (France)



*In order to remove Saint Chéron level crossing 36, Freyssinet used Autoripage® to move a 37 m long structure weighing 2,400 t and equipped with approach spans (a procedure patented by Freyssinet). Autoripage® over 21.50 m was completed in four hours during a 48-hour track closure.*
*Three 1,000 t jacks were used to move the structure over a bentonite bed, reaching a maximum speed of 12 m/h.*

## APS of a rail bridge in Dijon (France)

*As part of the Dijon bypass project (LINO), Freyssinet moved a 2,600 t structure over a distance of 38 m, using the air pad sliding method. It was positioned in two hours during a 45-hour track closure.*
*Twelve APS (Air Pad Sliding) modules, each with a capacity of 385 t, and four pushing jacks with a stroke of 1,200 mm and a capacity of 32 t each, were used to move the structure at a speed of 20 m/h.*

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*4 - Final sliding and backfilling*
*5 - Track back in service on Monday morning*

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