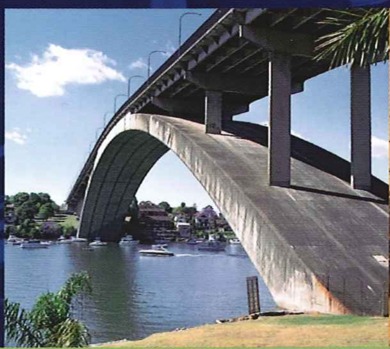
Freyssinet flat jacks

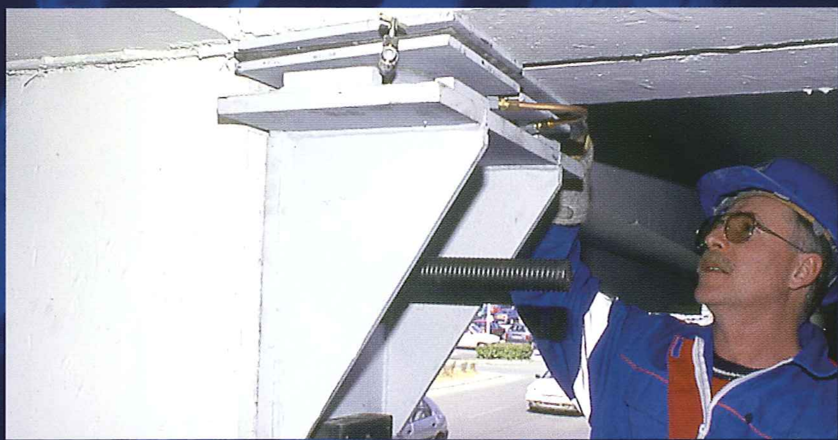


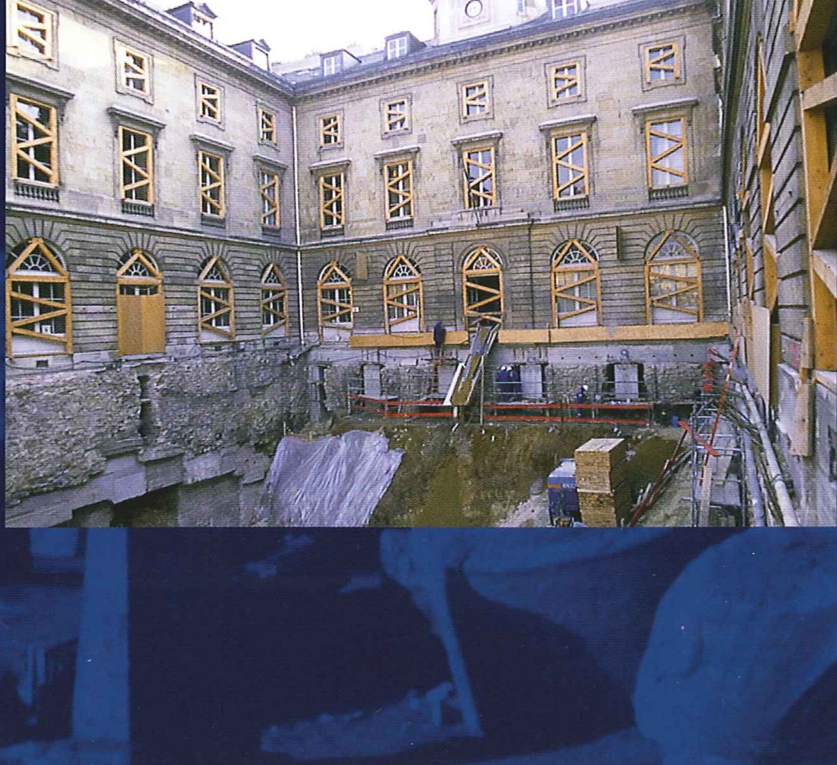
Freyssinet

Sustainable Technology

Freyssinet flat jacks

The Freyssinet flat jack is a thin hydraulic device capable of developing considerable forces in a simple and economic manner. Initially designed by Eugène Freyssinet as long ago as 1938, as part of a concrete prestressing means to be used under specific circumstances; flat jacks were subsequently implemented in numerous applications, in particular to exert or transmit forces while monitoring the relevant strains.



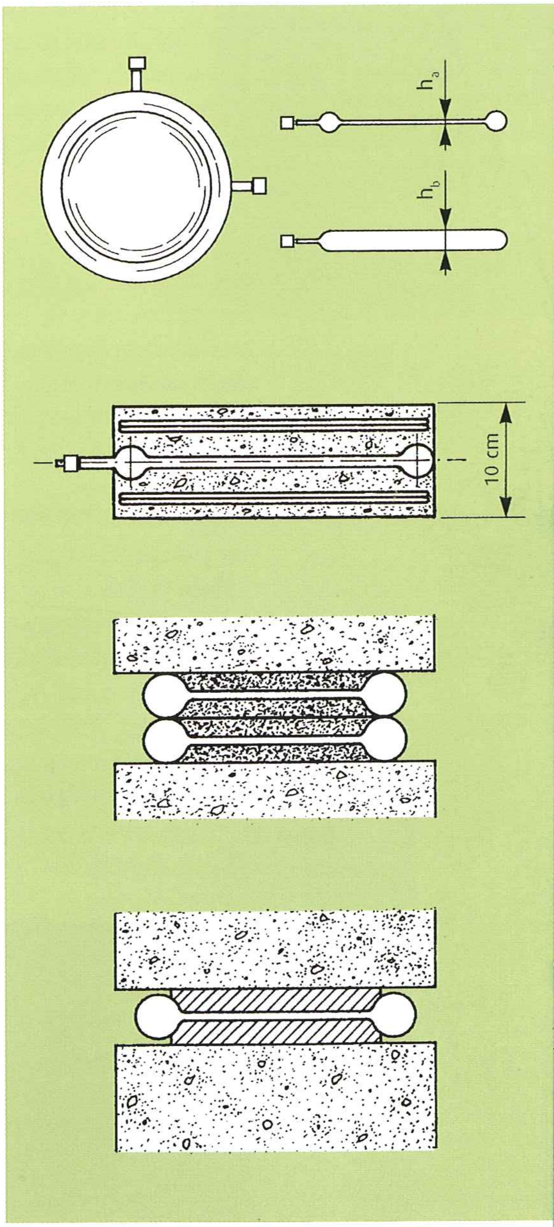


The Freyssinet flat jack is a deformable steel capsule made out of two cold-formed steel halves welded together, presenting a circumferential circular toric rim. Two pipe fittings, one of which serve as a vent, allowing a fluid to be injected under pressure to open the jack up to the height of the rim.

The figure opposite shows a plan view and cross section of a circular flat jack, before and after full injection. The stroke of the jack is the distance difference (hb - ha) between the two steel sheets. The force applied equals the pressure multiplied by the jack effective area. Due to its concave shape, it must be combined with an intermediate material filling the recess between the toric rim; this can be achieved in different ways:

Precast concrete blocks

When the available gap is large enough, the jack is embedded in a reinforced concrete block. For small flat jacks this block is generally 10 cm thick, i.e. 5 cm each side of the jack, each containing a mild steel reinforcement. Alternatively to reinforced concrete the flat jack may be embedded in a laminated elastomeric bearing.



Resin filling

When the available gap is limited, the embedding concrete block is replaced by a filling of, for example, epoxy resin mortar. The jack can thus be inserted in a cavity as deep as the rim diameter, plus a clearance of about 10 mm.

Steel plates

Steel plates are often used as intermediate filling plates. These must have a thickness greater than the central part recess depth. The edge in contact with the jack rim must be rounded off to a radius of 5 mm at least.

Utilisation of flat jacks

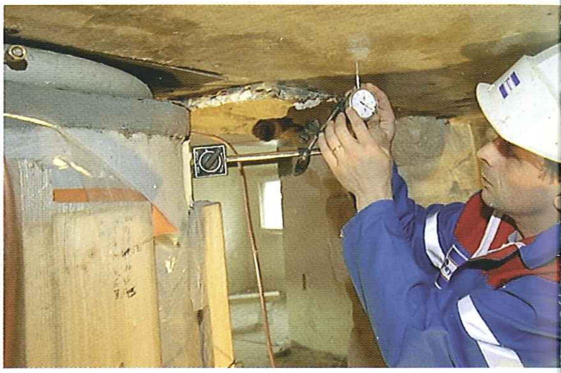
Shimming

Except in exceptional cases, a safety shimming system should be provided close to the flat jacks, capable of supporting the whole load in the event of an accidental leak.

Installation of flat jacks

Installation of jacks should be in full accordance with the instructions of the designer. Contact surfaces of neighbouring structures to flat jacks should be flat and parallel. The jack pipe fittings must remain accessible, otherwise extension pipes or hoses must be provided.

Hydraulic circuit



The hydraulic circuit should be carefully designed. With more than one jack in the circuit, it is recommended to fit each one with an individual valve. One pressure gauge is fitted for each jack or set of jacks. As the pressure due to supported loads may be different from one jack to the other, each jack or group of jacks must be connected in such a way as to allow each one to be operated separately.

Working pressure

When using flat jacks, one must always bear in mind that the stroke and the applied force are not proportional and depending on whether the reaction opposing to the jack is low or high, the stroke and the pressure must be maintained within limits not to be exceeded, e.g. those resulting from the table of standard circular flat jacks. The flat jack is generally used to transfer loads from an existing structural member to a new one without deformation of the total structure.

Methods of installation

The jack is set under pressure as follows, depending on its application:

- When the jack is to be used for a limited period and subsequently removed, it is common practice to inflate it with water for a short period of time or oil for a longer duration.
- If the jack can be relieved of its load by means of propping while it is being drained, it is possible to replace the water in the jack by a hardening product, generally a cement grout including an expansive admixture.
- It is possible to inflate the jack directly with an epoxy resin, which hardens rapidly without significant shrinkage.
- It is also possible to replace water or oil with a hardening product under load. This delicate application is used in special cases.

Dimensions and characteristics

Shapes

The standard shape is circular; however rectangular, square or oblong flat jacks can be obtained on request. Kindly consult us.

Stroke

The normal maximum stroke of the jack is equal to the diameter of the rim. When a larger stroke is necessary, the simplest solution consists of superposing two or more jacks. The maximum number of jacks used is determined by stability conditions of the system. Whenever the situation arises, kindly contact us.

Applied force and maximum pressure

The force applied by a flat jack depends on its effective working area. This force is equal to: P x S, P being the pressure and S the effective area of the jack, which depends on the expansion of the jack and on the type of filling plates used. Within the limits of the stroke defined below, the variation of effective area with regard to the expansion is not significant for most applications.

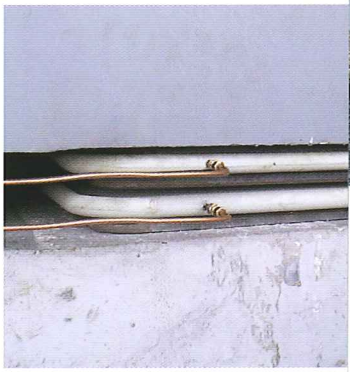
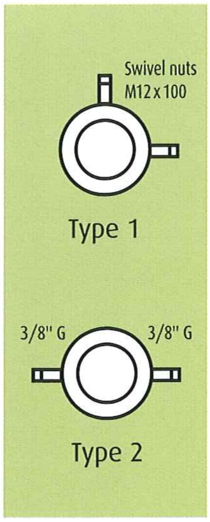


Table of standard circular flat jacks

External diameter (mm)	Stroke (mm)	Nominal force (kN*)	Type of pipe fittings**	Steel plates diameter/thickness mm
70	15	20	Type 1	38 / 6
120	20	70	Type 2	80 / 10
120	25	70	Type 1	65 / 12
150	25	150	Type 1	95 / 12
150	25	150	Type 2	100 / 12
220	25	400	Type 1	165 / 12
220	25	400	Type 2	170 / 12
250	25	500	Type 1	195 / 12
250	30	540	Type 2	190 / 14
270	25	600	Type 1	215 / 12
270	30	590	Type 2	210 / 14
300	25	800	Type 1	245 / 12
300	35	785	Type 2	230 / 16
350	25	1 100	Type 1	295 / 12
350	40	1 080	Type 2	280 / 18
420	25	1 700	Type 1	365 / 12
420	45	1 570	Type 2	330 / 20
480	25	2 400	Type 1	425 / 12
500	45	2 350	Type 2	410 / 20
600	35	3 700	Type 1	520 / 16
600	50	3 435	Type 2	510 / 25
700	50	4 660	Type 2	600 / 25
750	35	6 000	Type 1	670 / 16
750	50	5 500	Type 2	642 / 25
870	35	8 300	Type 1	790 / 16
920	35	9 100	Type 1	840 / 16
1 016	55	10 300	Type 2	902 / 25

* At the nominal maximum pressure of 15MPa. Higher pressure in special cases may be considered: contact us.

** Type 1 : M12 x 100 with 90° angular distance - Type 2 : 3/8" G with 180° angular distance. Other types are possible on request.



Examples of applications

The Freyssinet flat jack offers a wide range of use, when application or control of high forces is necessary or deformations have to be compensated.

Loading of supports and foundation grounds

Flat jacks enable the transfer of loads with pre-determined values onto new supports used to strengthen the structure or the foundation ground.

Strengthening of the bell towers of the Chaise-Dieu Abbey Church

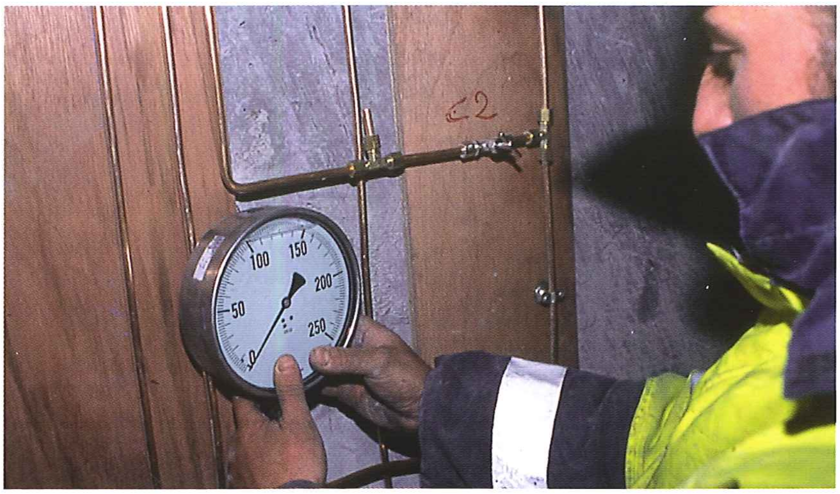
Both bell towers of this famous Romanesque monument had two sides resting on buttresses while the inner angles were supported by internal columns. These columns showed serious signs of alteration due to compression; therefore it was decided to transfer most of their loads to the lateral walls and buttresses, these being not heavily loaded. After construction of prestressed concrete trusses between the roof and the nave vault, the load transfer of the bell towers was carried out using flat jacks inserted between the trusses and the walls and buttresses which were left in the structure.

Prestressing by means of flat jacks

Every time a structure has natural bearing possibilities on the ground or when abutments can be economically built, it is possible to achieve prestressing using flat jacks.

The Mont Blanc Road Tunnel

A 2,900-metre-long roadway section of the Mont Blanc Tunnel was longitudinally prestressed using Freyssinet flat jacks. The roadway is the upper slab of a three-cell concrete box-girder, the cavities being used as ventilation ducts. The box-girder was prefabricated in approximately 10-meter-long segments; at 180 m internals, there is an active joint in which the flat jack blocks were inserted, each consisting of a build-up of seven oblong flat jacks, enabling a total stroke of 170 mm. The jacks were put under pressure in steps with oil, then, after stabilisation of shrinkage and creep losses, they were grouted and the joints concreted. The extremity blocks were anchored in the rock using prestressing tendons.



Thrust control

Arches can be loaded by exerting a thrust at their abutments or at the crown. Their deformations can be compensated or the distribution of bending moments can be improved.

The Gladesville Bridge, Sydney, Australia

The Gladesville Bridge, in Sydney, with a 304-metre-long span, is one of the world longest concrete arch bridges. Consisting of four independent arches, subsequently joined, it is entirely made up of prefabricated segments erected on a steel support. A battery of Freyssinet flat jacks was installed at each third of the length of every arch to lift them above the steel support and load them. As each arch was highly prone to deformations resulting from differential shrinkage and thermal effects, it was necessary to provide elaborate hydraulic circuits, including compensating flat jacks. Each battery consisted of 56 flat jacks, capable of exerting a 65 MN thrust and arranged in four layers in order to allow for a 100-mm stroke.

Compensation of deformation

In certain cases the variation in length due to shrinkage and to shortening of prestressed concrete must be compensated and this can be done by the action of flat jacks inserted in joints.

The Tourtemagne-en-Valais Dam (Switzerland) and the Nambe Falls Dam (New Mexico, USA)

These two arched dams, respectively 33 m and 42.5 m high, were designed with vertical active joints fitted with flat jack blocks.

The arch of the Tourtemagne-en-Valais Dam should normally be in full compression after filling-in. However tensions might have occurred locally due to variations of temperature, which could be as low as -15°C. To prevent these tensions, the dam was vertically and transversely prestressed. In order to prevent problems which may result from the transverse shortening due to prestressing, the dam was divided into five sections by four vertical active joints fitted with flat jacks 420 mm in diameter. These jacks were put under pressure at the same time as the tendons were tensioned; a slight thrust on the rock was exerted and the shortening of the arch could be compensated.

The arched section of the Nambe Falls Dam includes a vertical active joint fitted with 12 rectangular flat jacks, about 1.35 m by 1.83 m, set to compensate shrinkage of this 100-meter-long arch, by prestressing thanks to the imposed reaction against the abutments provided by the jacks.

The Olympic Velodrome at Montreal

The falsework supporting this remarkable structure was released by the use of flat jacks placed in batteries at the main abutments. A total of 226 flat jacks 920 mm in diameter were used to lift the structure clear of its temporary supports