FLAT JACKS

Low Height Steel Capsule Jacks

An Engineering Solution for Temporary & Permanent Load Transfer

THE WORLD... OUR PASSION!

www.fagioli.com
Flat Jacks

Applications

Flat Jacks are simple, practical devices for the civil or structural engineer wherever the application or control of large forces is required.

They are frequently used in the solution of unforeseen problems such as in remedial measures or structural additions. They are just as often used in new constructions in which they form part of the structural concept.

In the years since their invention by Eugene Freyssinet in 1934 many techniques have been evolved for applications such as:

- structural lifting
- underpinning
- control of thrust forces
- maintenance of constant thrust
- adjustment of support reactions
- prestressing
- structural pre-loading
- loading of seismic isolators
- arch striking
- control of settlement
- measurement of forces
- weighing of offshore structures
- permanent shimming

The benefits to the engineer stem from the versatility of Flat Jacks and the long experience of Fagioli Limited in the development of Flat Jack techniques:

- known forces
- precise control
- low height for limited access situations
- low bearing stress
- out of parallel tolerance between jacking surfaces
- temporary, removable jacks
- permanent, sacrificial jacks

General Description

Flat Jacks consist of a mild steel capsule, circular in plan, with a cross section that is initially dumb-bell shaped. The dished portions are fitted with ground steel thrust plates before the jack is placed between the surfaces to be jacked apart. When the jack is inflated with a liquid the hydrostatic pressure is transmitted by the flat portions of the capsule through the thrust plates, while the toroidal rim of the jack deforms to allow the flat faces to move apart.

The maximum operating pressure is only 150 bars (2,175psi). Flat Jacks thereby exert low bearing pressures on the jacked faces.

The maximum recommended opening stroke of a Flat Jack is equal to the depth of the toroidal rim - about 25mm (1in).

Two pipe connections are welded into the jack rim. One provides the inlet for inflation and the other serves as a vent during filling and is subsequently capped off.

Temporary Flat Jacks

Oil or water inflation

When Flat Jacks are to be used for a limited period and subsequently removed, inflation is normally done with hydraulic fluid, however certain circumstances may necessitate the use of water instead. For small number of jacks, requiring relatively small volumes of oil or water simple hand pumps may be used for inflation. Larger jacks or large numbers of jacks may require electric or diesel powered pumps.

Hydraulic circuits

Single or multiple Flat Jacks can be inflated individually or on inter-connected circuits. Each jack has a needle valve for locking and may be fitted with a pressure gauge if required.

Hydraulic circuits of any complexity can be made with steel tubing or flexible hydraulic hoses.

Jacking force

The force exerted by a hydraulic jack is the product of the fluid pressure and the effective piston area. In a Flat Jack the effective area varies and is not a simple function of its manufactured dimensions.

Reference 22 Calibration Graph
For ordinary applications Fagioli Limited provide calibration tables giving effective area for distance of opening which can then be correlated with hydraulic pressure to give the force exerted.

By careful inflation, Flat Jacks will accurately introduce the required force or deflection and, after an interval to ensure that the situation is static, steel wedges can be introduced, the Flat Jacks removed and the remaining gap grouted up. Alternatively the Flat Jacks may be part of a temporary support system and be removed with it.

**Permanent Flat Jacks**

**Cementitious grout or epoxy resin inflation**

Where a force is required to be permanently applied to a structure Flat Jacks are inflated under pressure with grout by means of a special purpose injection cylinder. The grout cures over a period of time to leave the force permanently applied. This type of application is suitable for pre-loading new or additional support steelwork in structures, underpinning works and structural bearing installation.

Cementitious grout is preferred over the previously widely used epoxy resin whenever possible mostly because it is more environmentally acceptable. However, in some cases, such as complex synchronised inflation of multiple jacks, resin is the only suitable injection substance.

This method is often used where sufficient room is not available for wedging or grouting the jacking gap.

**Flat Jack Selection Chart**

In certain circumstances it may be necessary to carry out the initial inflation on oil or water with grout or resin inflation being carried out at a later date. A transfusion system is then required.

**Transfusion of oil or water to grout or epoxy resin:**

There are two basic methods of transfusion of Flat Jacks that are pressurised with hydraulic oil or water.

### Single special transfusion Flat Jacks method:

At individual jack locations single special transfusion jacks, which are purpose designed and manufactured, can be transfused with grout or resin under load. The pressure within the Flat Jack is balanced and maintained throughout the process of transfusion.

### Additional Flat Jacks method:

If adequate space is available two Flat Jacks may be installed one above the other. The first is inflated with hydraulic fluid and adjusted as necessary over a period of time until the required condition is achieved. Then the second Flat Jack is inflated directly with grout or epoxy resin. The pressures in both Flat Jacks are balanced throughout until the oil or water Flat Jacks has closed and the inflation is completed on the grout or resin Flat Jack. This will then harden and both jacks will remain in position permanently.

### Tables

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Thrust at max pressure</th>
<th>Capsule diameter</th>
<th>Thrust plate diameter</th>
<th>Closed height</th>
<th>Maximum stroke</th>
<th>Required access gap</th>
<th>Flat jack Component wt.</th>
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**Detailing Guidelines**

The following are general guidelines on engineer’s detailing. Fagioli Limited will be pleased to advise on particular applications.

**Bearing Area.** The whole surface of the Flat Jack thrust plate must bear upon a jacking surface. Local stiffening, distribution steel or concrete may be necessary.

**Access Gaps.** The selection chart shows the thickness and minimum access gap requirements which must be provided. If the full travel of the jack is required then packing shims must be fitted to fill any remaining space before inflation.

**Tandem Jacks.** Where the required jacking distance exceeds the travel of a single jack, they may be stacked one on top of another and then inflated in sequence. Only the larger sizes of Flat Jack may be stacked more than two high. Fagioli should be consulted in such cases.

**Shear Resistance.** Flat Jacks must not be subjected to shear loads. Where necessary the Flat Jack must be protected from shear force by housing in a shear box or by other means.

**Inlet/vent positioning.** Flat Jacks can be made with suitable inlet positions where access is especially difficult.

**Transfusion Jacks.** When jacks are to be oil or water inflated and later transfused with cementitious grout they are manufactured with an internal pipe to ensure satisfactory displacement. This requirement should be specified at the time of detailing.

**Safety packs.** It is frequently advisable to make provision for safety packs when temporary Flat Jacks are intended to be in position for extended periods and at risk from mechanical damage from other activities in the jacking area.

**Complex Flat Jacking Systems**

In applications using multiple Flat Jacks, the hydraulic pumping circuitry can be arranged appropriately using pipe and compression fittings or flexible hoses and quick release couplings.

Individual gauges can be fitted to individual jacks, downstream of their needle valves, instead of, or in addition to, a common ring main gauge.

Differing loads in neighbouring jacks may thus be locked in the jacks and monitored as necessary.

For especially complex operations, solenoid valves, electronic pressure transducers and computerised control, monitoring and data logging systems may be used.

**Calibrated Flat Jacks & Weighing**

A Flat Jack which has been pre-opened fitted with a pressure gauge or transducer, sealed and then calibrated in a press can be used as a robust, accurate load cell.

This load cell Flat Jack can be placed in tandem with a standard Flat Jack of the same size.

The twin jacks are then installed beneath the structure at the weighing position. The weight of the structure taken by inflation of the standard Flat Jack, registers a pressure in the calibrated jack, which when cross referenced to the calibrated graph, provides an accurate weight.

Using this principle, Fagioli Limited have weighed offshore structures ranging from modules of several hundred tonnes to complete integrated decks of over 30,000 tonnes to an accuracy better than +/- 1%.

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