COULON
PIEUX
BATTUS

DRIVEN DUCTILE CAST IRON PILES

PLUG&DRIVE© 5.0 METRE TUBES: FAST, SIMPLE, SAFE!


KOMATSU

BUILDING A RELATIONSHIP BASED ON TRUST AND QUALITY WITH OUR CUSTOMERS

There are many advantages of prefabricated driven piles: quality guaranteed by industrial prefabrication, improvement of the ground characteristics by soil displacement, immediate control of the bearing capacity and real working speed. If the use of driven piles meets the expectations of professionals perfectly, this type of deep foundation is still struggling to renew itself. The special foundations industry is now changing and adapting to the demand of construction companies, decision makers and interested purchasers, especially at an environmental level.

With the ever-increasing development of the recycling and wood sectors, materials derived from recycled raw and renewable materials like centrifuged ductile iron or reconstituted solid wood have made their appearance in the special foundations sector and are now economic alternatives to be taken seriously.

Their mechanical properties are similar to traditional materials, whilst their resistance to hard driving is clearly better. The Eurocodes now integrate these new materials in consistent European standards for both structural and geotechnical design.

The sector of prefabricated driven piles is being modernized. The equipment is increasingly going in the direction of even more versatility and simplicity. Driven piles are now applied to many geotechnical fields involving deep foundations and soil improvement as well as retaining structures.

Driving and pumping machines are also evolving and becoming more accessible. The proposed equipment now has the advantage of being lightweight, compact and very efficient.

More modern, more accessible, more versatile. The prefabricated driven pile sector is expanding. Sarl Coulon Pieux Battus offers you innovative and competitive systems, complying with the highest European standards and evolutions within the profession.

Sales

Our easy-to-understand and efficient structure is here to serve your needs. You always deal with the same person who knows your imperatives and who gives you quick service. Our operating costs are reduced to a minimum to offer you the most economic deals. We develop solutions tailored to your specific needs.

Consulting

The person serving you is a specialist in the sector of special foundations. We have perfect control of our systems and share the experience of your daily challenges. We are with you in the field, and we are here to help you find high-performance alternatives, from the drawing board to the finished job.

Logistics

Our first concern is sustained supply and on-time delivery for all your projects. We deliver to site with trucks. We load into containers for sea freight. We offer partial or complete shipments, quick departure from stockpile or direct transfer from the factory. We look after all transport services.

Jerome Coulon, Director Manager

ENCOURAGING ECO-RESPONSIBLE BUSINESS IN THE SPECIAL FOUNDATIONS INDUSTRY

Spheroidal graphite cast iron is the material of choice for the design and use of prefabricated driven piles. In addition to combining remarkable impact resistance and a high ductility, it retains the traditional properties of grey cast iron: excellent mouldability and outstanding resistance to corrosion. Ductile cast iron has been used for many years in the manufacture of machinery, vehicles and water pipes. Ductile cast iron demonstrates in addition incomparable qualities for deep foundations.

100% recycled material

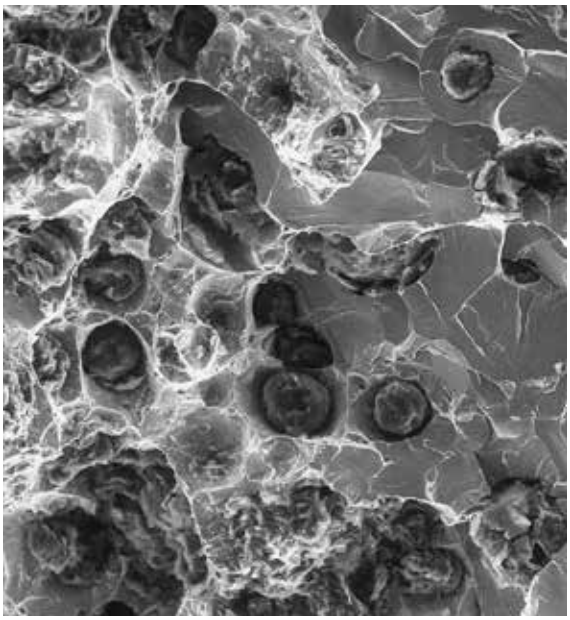
Spheroidal graphite cast iron is a 100% recycled material. It effectively contributes to the recycling and reuse of ferrous alloy waste. It successfully helps in preserving natural world resources.

The metallic cupola charge, routed locally by rail freight, comes entirely from the recycling line. It consists of mixed ferrous alloy scrap, automotive baled steel scrap and the foundry's own recovery. The recycled scrap is rigorously sorted by class and quality to ensure that the requirements for chemical composition and mechanical characteristics of the material are strictly met. At the end of its service life, ductile cast iron is in its turn fully recyclable.

Excellent mouldability

The mouldability of ductile cast iron enables integration of the Plug&Drive© joint system from the prefabrication phase. The spin cast tubes are shaped by centrifugation: the liquid metal at almost 1,400°C is forced by centrifugal action against the wall of the mould simultaneously in rotation and translation. It solidifies in contact with its water cooled surface.

The male and female tapered ends are exactly shaped in the cavity of the mould. They are formed together with the pipe shaft as a single-cast. This unique one-piece construction eliminates the need for later machining of the tubes and traditional pile splicing or butt welding on site.



Resistance to corrosion

Our ductile cast iron is 100% ferritic. Cast iron corrodes in a different way to steel, due to the fact that it has a notably higher content of silicon and carbon.

The annealing heat treatment of spheroidal graphite cast iron naturally entails the formation of an extremely adherent thin layer of iron oxide and silicate, called scale or casting skin, thus creating an efficient and sustainable protection against corrosion.

i Spheroidal graphite cast iron is commonly called ductile cast iron. Ductile cast iron is an iron-carbon-silicon alloy containing more than 3.5% of carbon and more than 2.0% of silicon. The high electrical conductivity of spheroidal graphite cast iron makes it possible to promote effectively underground thermal energy storage for heating and cooling (energy piles).

Impact resistance

Unlike grey cast iron, in which the graphite appears in the form of flakes, the microstructure of ductile cast iron inserts the free carbon in the form of spheres, thus eliminating brittleness. Ductile cast iron acquires its resilience and its high ductility through magnesium treatment of the liquid metal. The explosive reaction takes place shortly before the centrifugal casting.

Ductile cast iron piles withstand very hard driving and offer a remarkable penetration force. The design of ductile cast iron piles means that driving and handling stresses which can occur during pile installation or hoisting the tubes are no problem at all.

Constant industrial quality

The prefabrication of ductile cast iron piles ensures constant industrial quality and plentiful availability of products. Thanks to a fast production process, the tubes are readily available from stock in standardised dimensions. Large quantities can be planned in accordance with the factory and the schedule of the construction project.

The industrial prefabrication ensures consistent quality of the tubes attested by the CE marking, authenticated by the NF EN 10204 test certificates and the NF EN ISO 9001 certificate to quality assurance.

The solid waste resulting from fusion (slag, zinc dust) are separated, treated and fully recycled. The after-burning of residual gases from the cupola furnace allows efficient energy recovery and savings. Finally the closed water cooling system operates independently and respectfully of the outside hydrological environment.

DEVELOPING PREFABRICATED PILE SYSTEMS SUITED TO THE CURRENT MARKET REQUIREMENTS

The installation method of prefabricated driven piles offers an undisputed advantage: the certainty of continuity over the entire pile length. The certainty of continuity not only makes the integrity tests on the pile shaft unnecessary, it also guarantees the structural resistance of the pile and secures an optimal mobilization of both skin friction and tip resistance. The ductile cast iron pile system and the Plug&Drive© spigot and socket joint have been developed to assure absolute integrity and continuity of the piles.

Resistance to bending

The system of prefabricated ductile cast iron piles consists of 5.0 metre standard length tubes whose tapered male and female ends connect together and constitute the unique Plug&Drive© spigot and socket joint. This design offers high degree of stiffness and resistance to bending. It allows you to overcome having single sections of great length and traditional pile splicing or butt welding on site, whilst guaranteeing perfect alignment of the tubes.

The Plug&Drive© spigot and socket joint is self-locking and irreversible. After their quick concentric connection, the male and female tapered ends embed rigidly by absorbing part of the driving energy. Assembly is by cold welding: the expansion and contraction of the two tapered ends occur under high contact pressure by elastic deformation of the ductile cast iron.

Modular system

The Plug&Drive© spigot and socket joint allows infinitely variable pile lengths. Ductile cast iron piles may be extended or cut off at any time and therefore easily adapt to real subsurface conditions. Installation pile lengths naturally adapt to variable depth-to-bedrock or to potential irregularities of soil layers' characteristics and thickness, ensuring the necessary and adequate bearing capacity for each individual pile.

Designed as a very flexible system, the Plug&Drive© spigot and socket joint eliminates waste on pile lengths: excess lengths are fully reused as a starter piece for the next pile. Direct pile cutting-off to project level reduces time and cost of deep foundations, thus eliminating the traditional pile breaking off and allowing the immediate scheduling of concrete work.

The Plug&Drive© system is extremely stiff to bending and resistant to compression. Resistance to bending of our tapered spigot and socket joint is always greater than that of the pipe shaft alone, building the strength of the system. Plug&Drive© eliminates threaded coupling, mechanical assemblies and butt welding on site.

5.0 metre standard length

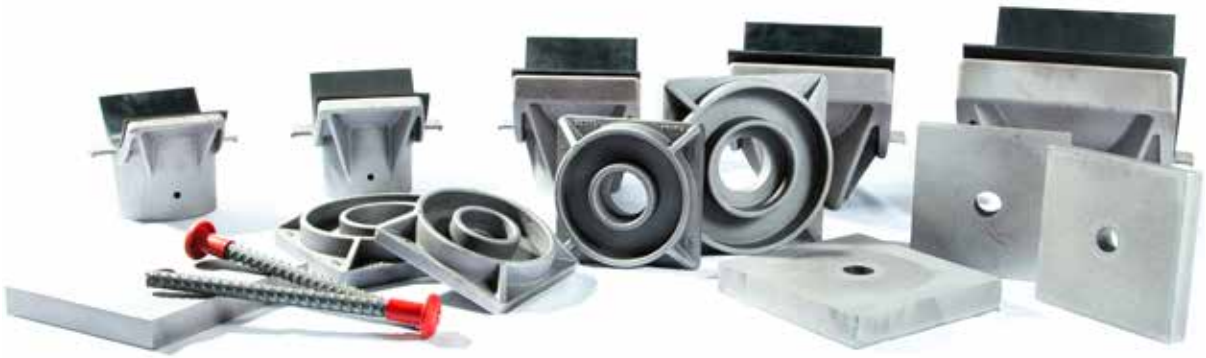
The 5.0 metre standard length tubes allow you to free up considerable space on the building site and have more room for handling and work. The easy and safe stacking of 5.0 metre bundles seriously reduces the storage areas. It also allows you to substantially reduce transport costs. Up to 1,050 metres of pile lengths can be delivered by truck to the construction site. For overseas destinations, the 5.0 metre standard length tubes are readily and surely transported by ocean freight in 20-foot dry box containers.

The combination and complementarity of our Plug&Drive© joint system with a 5.0 metre standard length result economically on the job site in quick mobilization, high production rate and low investment costs. The absence of waste and drill cuttings, together with the easy storage and handling of 5.0 metre standard length tubes also greatly favours safety and tidiness on construction sites.

Complete cast iron range

A complete range of tubes and accessories in ductile cast iron is available for all types of projects. The centrifugally cast 5.0 metre standard length tubes are available in two diameters and five thicknesses. They offer a progressive scale of capacity up to more than 2,000 kN ultimate resistance and allow economic selection according to the specific pile load distribution of the project.

Pile accessories made of ductile cast iron provide a great freedom of design: oversized conical grout shoes for simultaneous drive and grout technique, self-centring bearing plates, external splice for working in low overhead conditions, pipeline saddles for the foundation of water pipes. The mouldability of cast iron allows you to optimize the functionality of pile accessories for many installation methods and different kind of connection to the superstructure, by adapting to all types of grounds and all needs.



The cast iron 5.0 metre length tubes are immediately available from stock in standardized dimensions: diameters 118 mm and 170 mm, wall thickness 7.5 mm, 9.0 mm, and 10.6 mm. Other dimensions can be produced on request. Our foundry specialists have recognized experience to rapidly develop pile accessories specifically for your needs.

PROMOTING NEW COMPETITIVE, HIGH-PERFORMANCE DRIVING TECHNIQUES

Driving prefabricated piles reduces costs and delays for special foundations and helps to assure deadlines are met. Ductile iron piles also differentiate from other piling methods by the particularity of offering no skin friction resistance when being driven since the pile shaft slides without resistance in the mortar or grout. All the driving energy remains concentrated on the drive shoe, so that it is possible to work with light driving equipment.

Versatile equipment

The use of compact and lightweight equipment decreases requirements in terms of access, piling platform and workspace taken up on the job site. Standard equipment consists of a powerful and high impact rate hydraulic breaker mounted on a tracked excavator. It is available very quickly and easily moveable. The system reduces the investment and set-up costs by notably cutting mobilization and demobilization times.

Simultaneous drive and grout technique

Ductile iron piles combine driving installation and simultaneous injection methods. The starter pile piece is fitted with an oversized conical shoe which is open upwards, but tapered downwards. Simultaneously when driving the pile, the annular space formed by displacement between the pile shaft and the surrounding soil is filled with mortar or grout. Depending on the nature of the ground and injection pressure, the mortar penetrates more or less deeply into thesurrounding soil. Even in artesian groundwater, the water does not hinder pile installation in any way. The hardened grouted zone around the pile shaft constitutively builds up a bonding to the surrounding soil, providing high skin friction resistance in addition to the tip resistance. The mortar or grout also guarantees an effective long-term corrosion protection of the pile shaft.

Pile lengths can be easily reduced or extended according to the project requirements by adding additional pile sections with the Plug&Drive© joint system. Piles of more than 50 m have already been installed.

Soil displacement

The displacement piling method eliminates the costs of drill cuttings removal and consequently helps reducing the on-site traffic. When the ground is contaminated, this also eliminates the additional costs resulting from treatment and disposal. The compression of the surrounding soil beneath the pile tip and along the pile shaft increases the mechanical characteristics of the ground and therefore strongly improves the skin friction and end bearing capacity of the pile.

Measuring soil resistance to pile insertion results in an immediate control of pile bearing capacity during installation. Monitoring penetration rates versus depth by driving easily documents successful pile installation and allows you to reveal the irregularities of the ground locally and to act accordingly, thus eliminating uncertainties due to soil variations.

The light and compact equipment allows piling in 7.5 m low headroom conditions (5.0 m by using external splices) and up to 2.5 m limited access (isolated plots). The excavator boom can reach pile locations up to 4.5 m from the machine and at different platform levels. For occasional work, driving and pumping equipment is easily available for hire.

High penetration force

Regardless of pile length, the impact energy remains wholly concentrated on the shoe. This explains the remarkable penetration force and driving performance of ductile iron piles as well as the low vibration level. The induced ground vibrations are generally confined to the immediate vicinity of the pile.

Peak particle velocities (PPV) are much lower than the critical threshold for very sensitive construction projects. Ductile iron piles can be installed extremely close to neighboring buildings and up to 40 cm from existing structures.

Ductile iron piles are commonly driven with hydraulic hammers using state-of-the-art breaker technology. Designed for heavy work (1.7 to 2.5 t) they have a high impact rate (300 - 800 blow per minute) and a single blow energy of 3,000 to 5,000 Joules. This technique ensures better bearing capacity than the vibro piling installation method.

Speed of installation

The rate of work is high. The daily output can reach up to 200 - 400 metres depending on the installation method used. A crew consists of two persons. An additional operator is required for injection if the piles are grouted. Ductile iron piles are directly cut-off to project level. This eliminates costs and delays caused by traditional pile breaking and allows direct planning of the concrete works.

Closed-ended driven piles

In their most basic form, ductile iron piles are top-driven to refusal and without grout injection. They are commonly used as end-bearing piles and deeply embed into bedrock or a very firm cohesive substratum underlying thick soil layers of very poor condition. The bore of closed-ended ductile iron piles can be concrete-filled immediately after driving is achieved, thus creating a composite cast iron and concrete structure and giving additional strength.

The hardened steel driving shanks are machined from a solid piece and directly take the place of the conventional working tools in the hydraulic hammers. They feature two shoulders for driving tubes of diameter 118 and 170 mm. The grout box allows shaft-grouted piles to be driven with the simultaneous drive and grout technique. It is supplied directly from the pump through a hose of 50 mm.

INTEGRATING THE ADVANTAGES OF UNIFIED MODERN DESIGN AND 30 YEARS OF EXPERIENCE

Within the meaning of standard NF P 94-262 and according to the chosen installation method, the prefabricated ductile cast iron piles are to be considered either as shaft-grouted piles (BE, class 4, category 10) or as closed-ended piles (BAF, class 4, category 12). The standard NF EN 12699, execution of special geotechnical works, for displacement piles applies to both shaft-grouted and closed-ended piles.

Economic pile design

The design of prefabricated ductile cast iron piles is independent of driving and handling stresses. The high impact resistance of spheroidal graphite cast iron and the 5.0 metre long modular elements of high inertia allow you to put all the structural attributes of the material to the sole benefit of design.

The choice of the ductile cast iron tube is independent from that of the external pile dimensions. The oversized conical grout shoes can combine with all types of tube, whilst the Plug&Drive© spigot and socket joint allows ductile iron piles to be readily extended or shortened at any time. The determination of pile diameter and pile length is not governed by the choice of tube. The verification of bearing capacity (geotechnical design) and cross section resistance (structural design) are absolutely independent.

Closed-ended and shaft-grouted piles

According to whether the geotechnical profile promotes the use of end-bearing or skin friction piles, the choice between closed-ended and shaft-grouted piles is to be made on the basis of technical and economic criteria, whilst seeking to guarantee the sustainability and bearing capacity of the piles and on the other hand to optimize the cost of the foundations.

Shaft-grouted ductile iron piles are commonly driven to predetermined lengths in homogeneous or multilayer soils. The shaft grouting allows you to develop high skin friction and considerable tip resistance in both fine- and coarse-grained soils thanks to the creation of an interfingered soil/ pile interface and to the lateral soil displacement.

Closed-ended ductile iron piles are used when very poor ground layers of mostly high and variable thickness must be driven through, and when embedment in the bedrock is possible. They are driven to refusal and naturally adapt to variable depth-to-bedrock. The structural strength of the tube, subsequently filled with mortar, is then decisive.

i The aptitude for use of ductile cast iron piles in the construction industry is validated by European Technical Approval ETA-07/0169 and the resulting CE-marking. At your disposal: our pile design guide provides a complete methodological note for the design of ductile cast iron piles in accordance with the Eurocodes (based on NF P 94-262).

Concrete, mortar and grout

Ductile cast iron piles can be driven alone and then do not require any addition of concrete (closed-ended end-bearing piles embedding in the bedrock). However, in most cases, ductile cast iron piles are installed in combination with shaft grouting and/or pile core filling using concrete, mortar or grout.

The aggregation of concrete, mortar or grout with the metal tube makes it possible to increase the structural resistance of the pile by creation of a cast iron and concrete composite structure. The bearing capacity of the pile is increased by improving the soil/pile interface with shaft grouting, and the sustainability of the pile is assured through the creation of effective corrosion protection.

Verification of the bearing capacity

The bearing capacity of ductile iron piles can be verified during their installation by evaluation of the soil penetration resistance to the driving energy applied. Recording penetration rates versus depth gives a direct correlation between the driving time and the unit skin friction and tip resistance design values.

This efficient method makes it possible to increase the structural safety level of the project and to reduce foundations costs by naturally adapting the pile lengths to the variable ground conditions actually encountered. It means a systematic quality control of the successful installation of piles and a verification of homogeneity of the real subsurface conditions.

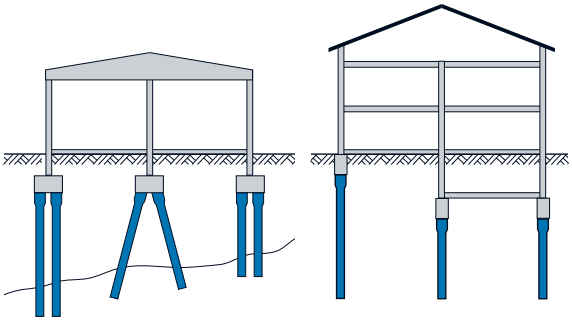
i

A minimum 5 cm cover of appropriate concrete, mortar or grout is recognized as effective corrosion protection and enables you to overcome the calculation of corrosion allowance (loss of thickness). The strength classes may vary from C20/25 to C35/45. In the case of closed-ended piles, concrete pile core filling may also be implemented.

OFFERING A VERSATILE SOLUTION APPROPRIATE TO MANY FIELDS OF USE

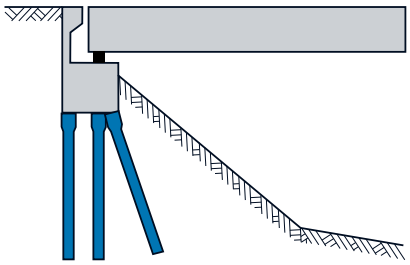
Ductile cast iron piles are prefabricated driven piles of small diameter: compact shape with low displacement and minimum ground disturbance. They combine a lot of benefits that enable them to solve many problems advantageously from both economic and technical points of view. Their specific methods of installation (i.e. the simultaneous drive and grout technique) and the resulting lightweight equipment make them as appreciated for large construction projects as for small and medium-scale piling jobs.

Residential and industrial buildings



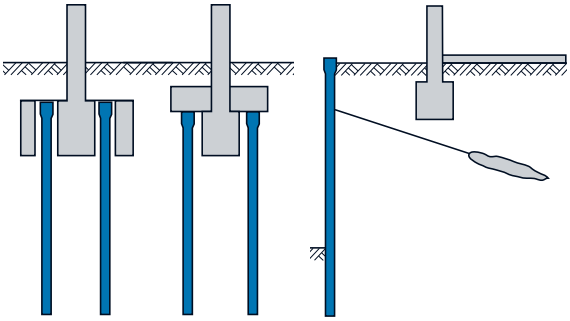
Ductile cast iron piles are especially appropriate as compression piles. Thanks to the installation by displacement and to the simultaneous drive and grout technique, shaft-grouted ductile iron piles are suitable for use as combination of friction and end-bearing piles. When the geotechnical conditions allow, the closed-ended driven piles are the best compression piles. The wide range of applications includes any real estate project as well as industrial buildings. The reduced space taken by the pile caps brings significant savings when the costs for removal/disposal of excavation material and for concrete volumes are globally addressed.

Civil engineering works



Thanks to the significant inertia of the continuous metallic tube and the easy installation of raked piles (inclination possible up to a 45 degree angle), ductile cast iron piles can support horizontal loads and high bending moments. They are particularly indicated for use in civil engineering works of appropriate dimensions (deep foundations of bridge piers and abutments for road and rail infrastructures) and in projects located in seismic zones.

Underpinning, retaining walls

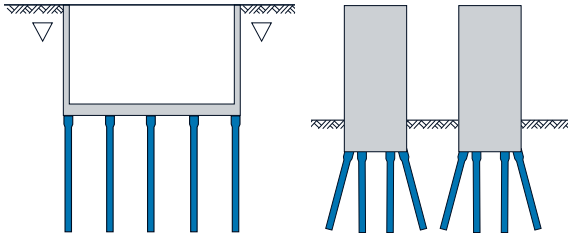


Ductile cast iron piles allow work under a limited height of 7.5 m or even 5.0 m and accessibility up to 2.5 m in width. Used in low headroom conditions, they offer impressive suitability for extension projects, rehabilitation of warehouses or strengthening of old foundations. The absence of excavated material and the low level of vibration makes their use all the more significant when the conditions of access and workspace are difficult.

For the purpose of temporary or permanent support works, cantilever or tied retaining walls of appropriate dimensions can be installed quickly and cost-effectively by using driven ductile cast iron piles.

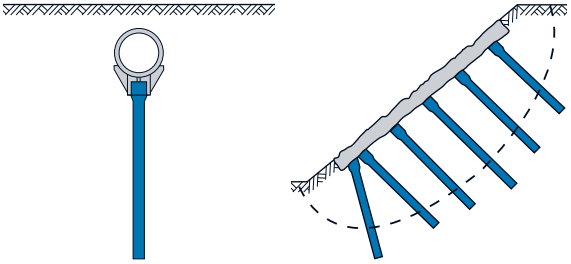
i Acoustic protection: the construction of noise barriers for roads and railways requires compact and mobile equipment (linear job site in confined workspaces). The absence of spoils and risk of ejection allows you to secure the operational traffic lanes. The storage, working and handling areas are reduced to the minimum in order to limit the constraints on traffic.

Building excavations, slender structures



Ductile cast iron piles can also be used effectively as tensile piles and give protection against hydraulic heave in deep excavations. Tensile forces are transferred to the soil by an additional reinforcement bar inserted in the tube core filled with mortar or grout (piled raft foundations, purification basins, underpasses, etc.). For foundations subjected to cyclic axial loading (tensile and compressive forces), the bilateral load capacity of ductile cast iron piles makes them extremely economic for slender structures such as silos, power line pylons, catenaries, wind turbines or antenna towers.

Pipe-laying, slope stabilization



Underground pipe-laying on ductile cast iron piles represents an economic alternative to an expensive soil replacement method. The process allows the installation of the piles at different platform levels and an accurate vertical positioning of pipes, to durably prevent settlements.

Slope stabilization, mountain roads, and preparation of ski runs: the ductile cast iron piles can be driven vertically up to nearly horizontally for protection against small-scale landslide hazard.

Energy piles: the excellent thermal conductivity of ductile cast iron and the easy insertion of geothermal closed-loops inside the driven prefabricated tubes allow a double use of the piles. They can be designed as structural elements to transfer the foundation loads to deeper soil strata and as geothermal heat exchangers (heating and cooling for buildings).

TECHNICAL SPECIFICATIONS

d	outside diameter	[mm]	118	118	118	170	170	170	170
t	wall thickness	[mm]	7.5	9.0	10.6	7.5	9.0	10.6	13.0
	construction length	[m]	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	commercial weight	[kg/m]	21.0	24.4	28.0	33.8	37.2	42.6	52.0
	commercial weight	[kg/tube]	105	122	140	169	186	213	260
	commercial weight	[kg/bundle]	1,575	1,830	2,100	1,352	1,488	1,704	2,080
	packing unit	[tubes/bundle]	15	15	15	8	8	8	8
	packing unit	[m/bundle]	75	75	75	40	40	40	40
	bundle length	[m]	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	bundle width	[m]	620	620	620	720	720	720	720
	bundle height	[m]	420	420	420	375	375	375	375
Aa	section of ductile iron	[mm^2]	2,604	3,082	3,577	3,829	4,552	5,308	6,412
Ac	section of concrete	[mm^2]	8,332	7,854	7,359	18,869	18,146	17,390	16,286
Ia	moment of inertia of ductile iron	[cm^4]	399	461	521	1,267	1,480	1,693	1,989
Ic	moment of inertia of concrete	[cm^4]	552	491	431	2,833	2,620	2,406	2,111
Wel	elastic section modulus	[cm^3]	68	78	88	149	174	199	234
Wpl	plastic section modulus	[cm^3]	92	107	123	198	234	270	321
Npl,Rd	compression resistance	[kN]	972	1,117	1,267	1,540	1,759	1,988	2,323
Vpl,Rd	shear resistance	[kN]	306	362	421	450	535	624	754
MRd	bending moment	[kNm]	29.3	34.3	39.3	63.4	74.7	86.3	102.8
EI	bending stiffness	[kNm^2]	679	783	885	2,153	2,515	2,879	3,382

The resistances of the tubes are determined according to the French design standard NF P 94-262 for the implementation of Eurocode 7 (deep foundations) and the Eurocodes that relate to them. The calculations are conducted with the following cast iron specifications: yield strength Rp0.2=320 MPa, module of elasticity E=170,000 MPa.

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Photos

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Design : SARL Maelstrom Studios | contact@maelstrom-studios.fr | www.maelstrom-studios.fr