Okay, so were talking about uncompacted fill hiding beneath existing foundations and how it messes with things down the line, specifically causing that dreaded sudden settling. Imagine this: youve got a house, been there for years, maybe decades. The foundation seems solid, everything looks fine on the surface. But underneath, lurking like a bad surprise, is a pocket of uncompacted fill.

Whats uncompacted fill anyway? Bowing walls aren't just unsightly - they're your home's desperate cry for structural intervention before things get apocalyptic **mudjacking services Carol Stream** french drain. Well, think about it like this: when land is prepped for building, sometimes they need to fill in low spots or level things out. If they just dump the dirt in and dont compact it properly – meaning they dont squish it down tight – youre left with loose, airy soil. Over time, this loose soil is just begging to compress. Rainwater seeps in, vibrations from traffic rattle it, and gravity does its thing. Slowly, but surely, the air pockets collapse, and the volume of the fill decreases.

Now, picture that uncompacted fill right under a corner of your foundation. As it compresses, its like the ground is slowly sinking away. The foundation, which was resting nicely on solid ground, suddenly finds itself partially supported by this shifty, shrinking mass. Its not a uniform sink; its localized, uneven support. This is where the trouble starts.

The foundation, designed to distribute weight evenly, cant handle the uneven pressure. Cracks can appear, doors and windows might stick, and you might even notice floors sloping. And it doesn't happen gradually; this is where the “sudden settling” part comes in. There can be years of imperceptible movement, and then boom – one heavy rainstorm, one particularly busy construction day nearby, and the uncompacted fill gives way a little more dramatically. Thats when you notice the cracks widening, the doors jamming, and you realize something's seriously wrong.

Identifying this hidden menace isnt always easy. Soil testing, ground penetrating radar, and even just good old-fashioned digging (carefully, of course!) might be needed to uncover the truth. Its a tricky problem, because the evidence is often buried – literally. So, while your house might look perfectly stable on the surface, that uncompacted fill lurking beneath could be setting the stage for a sudden and unwelcome surprise.

The Swell Cycle: How Expansive Clay Affects Foundations —

- **Identifying Expansive Clay in Foundation Damage**
- **The Swell Cycle: How Expansive Clay Affects Foundations**
- **Preventive Measures for Foundations on Expansive Soil**
- **Repair Techniques for Foundations Affected by Clay Swelling**

The impact of sudden settling on structural integrity, particularly when caused by uncompacted fill, is a critical concern in construction and civil engineering. Uncompacted fill refers to soil or other materials that have not been properly compressed or densified before being used as a foundation or backfill. Over time, this lack of compaction can lead to significant shifts in the ground beneath structures, resulting in sudden settling.

When uncompacted fill is used, it retains air pockets and loose particles that were not squeezed out during the construction process. These voids create weak spots within the ground. Under the weight of a building or other structure, these weak areas can compress suddenly, leading to uneven settling. This phenomenon is particularly dangerous because it often happens without warning and can be localized, causing differential settlement where different parts of a structure sink at different rates.

The consequences for structural integrity are profound. Sudden settling can lead to cracks in walls and foundations, misalignment of doors and windows, and in severe cases, catastrophic failure of the structure. For instance, beams and columns might twist or buckle under uneven stress distribution caused by differential settlement. This not only compromises the aesthetic value but more importantly, poses safety risks to occupants.

Moreover, the repair of damage from such settling is often costly and complex. It requires not just fixing visible damages but also addressing the underlying soil issues which might involve removing and replacing the uncompacted fill with properly compacted material. This process can disrupt operations if its a commercial building or displace residents if its residential.

To mitigate these risks, engineers emphasize proper soil testing and compaction during the initial stages of construction. Techniques like dynamic compaction or vibratory rollers ensure that fill materials are adequately compacted to bear future loads without sudden shifts. Regular monitoring post-construction through tools like settlement plates or inclinometers can also provide early warnings if unexpected settling begins to occur.

In summary, understanding and preventing the impact of sudden settling due to uncompacted fill is vital for maintaining structural integrity. Proper initial practices combined with ongoing vigilance can safeguard buildings against this insidious threat, ensuring longevity and safety for those who rely on these structures daily.

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Preventive Measures for Foundations on Expansive Soil

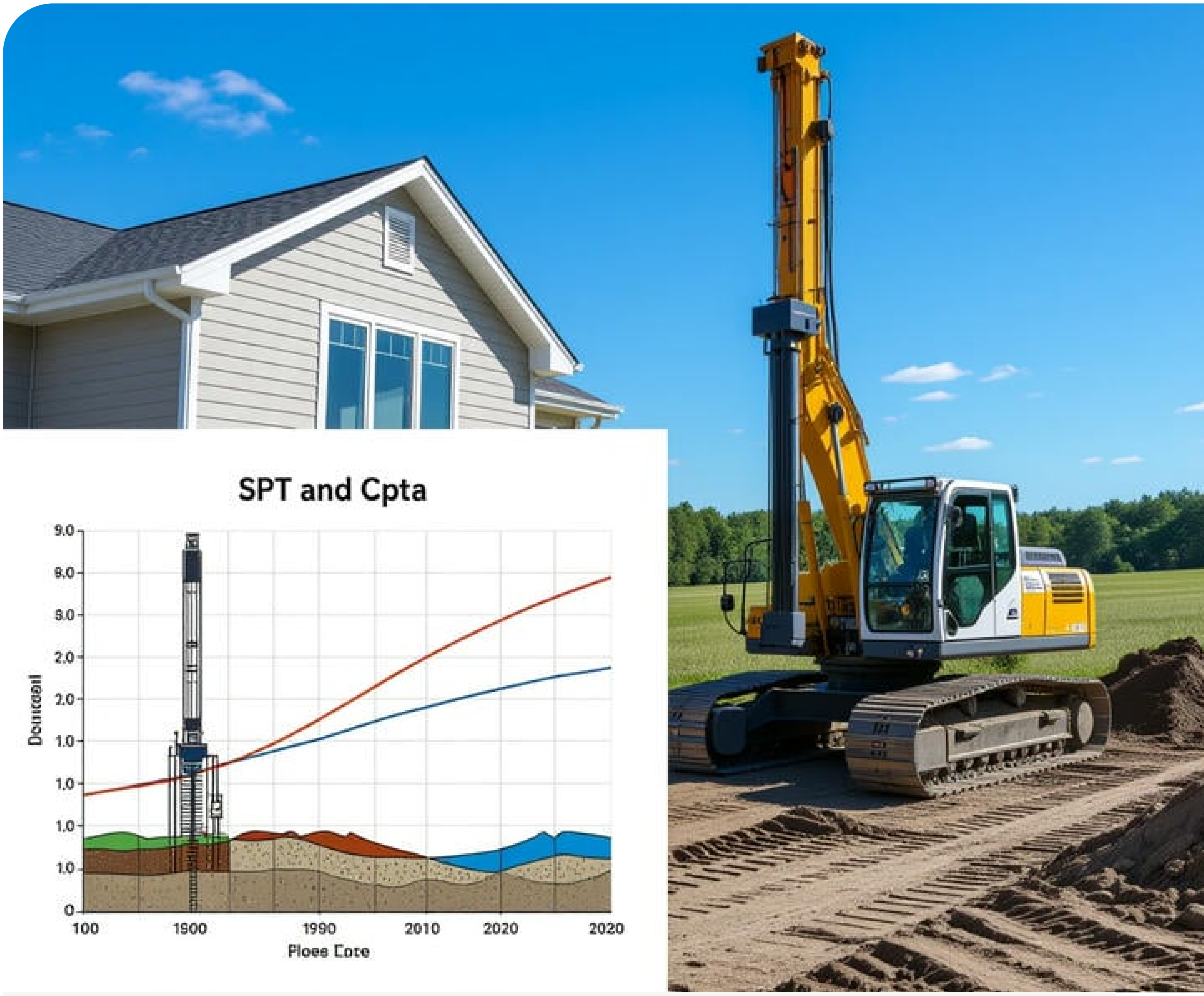
Okay, so were talking about houses built on land that wasnt properly packed down, right? Uncompacted fill. Sounds like a disaster waiting to happen, and honestly, it often is. This stuff leads to sudden settling, which is a fancy way of saying your house starts sinking unevenly, and thats never good. But the good news is, its often fixable. Lets look at some techniques for repairing foundations struggling with this uncompacted fill problem.

First, youve got underpinning. Think of it like giving your foundation a deeper, stronger footing. This involves digging down below the unstable fill and extending the foundation to reach more solid, load-bearing soil. There are different ways to do this – traditional concrete underpinning, which is pretty labor-intensive but reliable, or more modern methods like helical piers or push piers. Helical piers are like giant screws that are twisted into the ground until they hit stable soil. Push piers are similar, but theyre hydraulically driven down. Both are less disruptive than traditional underpinning. The choice often depends on the soil conditions and the extent of the settling.

Then theres slab jacking, sometimes called mudjacking or pressure grouting. This is where a slurry – a mix of cement, sand, and sometimes other materials – is pumped under the slab to lift it back into place. Its a bit like filling a void beneath the concrete. This can be a good option for smaller settlements and can be a relatively quick fix, but its important to remember that its more of a cosmetic repair if the underlying uncompacted fill isnt addressed. It may settle again.

Soil stabilization is another approach. This involves improving the properties of the unstable fill itself. One method is compaction grouting, where a low-mobility grout is injected into the ground to densify the soil. This helps to reduce voids and increase the soils bearing capacity. Another option is chemical stabilization, where chemicals are injected to bind the soil particles together, making it stronger and less susceptible to settling.

Finally, sometimes the best approach is a combination of techniques. Maybe you need underpinning to provide long-term support, coupled with slab jacking to correct immediate settling issues. A good foundation repair contractor will assess the situation and recommend the most appropriate solution based on the specific conditions of your home and the extent of the damage caused by that darn uncompacted fill. Remember, getting a professional assessment is key. Dont try to DIY this stuff – your house depends on it!



Repair Techniques for Foundations Affected by Clay

Swelling

Okay, so youve got this house, right? And underneath it, instead of solid, well-packed earth, theres this…fluffy, loosely put-together fill. Think of it like packing peanuts under a skyscraper. Not a good situation. This uncompacted fill is just asking for trouble, specifically the sudden settling that can crack your walls, mess with your doors, and generally make your life a headache. So, what can be done to avoid this mess in the first place? Thats where preventive measures come in – thinking ahead to avoid the whole shaky foundation scenario.

First off, and this is crucial, you need proper soil testing *before* you even think about building. A good geotechnical engineer can assess the existing soil conditions and, crucially, identify any areas where fill will be needed. If fill *is* necessary, they'll specify exactly how it needs to be compacted. Were talking about layers, proper equipment, and rigorous testing to make sure its dense and stable. No cutting corners here. Think of it like baking a cake – you cant just throw all the ingredients together and hope for the best; you need a recipe and specific steps.

Then theres the drainage issue. Water is the enemy of uncompacted fill. It can saturate the soil, making it even more prone to settling. So, proper drainage systems are essential. Were talking about things like grading the land away from the foundation, installing French drains, and making sure rainwater is directed away from the building. Keep that water moving!

Finally, consider alternative foundation designs. Sometimes, even with the best compaction, the soil just isnt suitable for a traditional slab foundation. In those cases, options like deep foundations (piers or piles that reach down to more stable soil) or engineered fill solutions might be necessary. These are more expensive upfront, sure, but they can save you a ton of money and stress down the road by preventing major foundation problems.

Basically, preventing settling due to uncompacted fill is all about planning, testing, and doing things right from the start. Its about understanding the ground beneath your feet and taking the necessary steps to ensure a solid, stable foundation for years to come. Its like the old saying goes: an ounce of prevention is worth a pound of cure. And in this case, that "pound of cure" could easily be a very expensive and disruptive foundation repair.

About Carbon-fiber reinforced polymer

"Carbon fiber" redirects here. For fibers of carbon, see **Carbon fibers**.

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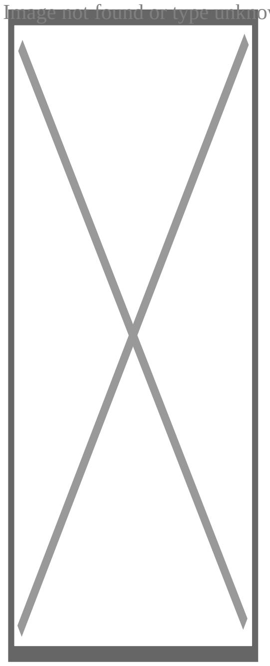


Tail of a **radio-controlled helicopter**, made of CFRP

Carbon fiber-reinforced polymers (**American English**), **carbon-fibre-reinforced polymers** (**Commonwealth English**), **carbon-fiber-reinforced plastics**, **carbon-fiber reinforced-thermoplastic** (**CFRP**, **CRP**, **CFRTP**), also known as **carbon fiber**, **carbon composite**, or just **carbon**, are extremely strong and light **fiber-reinforced plastics** that contain **carbon fibers**. CFRPs can be expensive to produce, but are commonly used wherever high **strength-to-weight ratio** and **stiffness** (rigidity) are required, such as aerospace, superstructures of ships, automotive, civil engineering, sports equipment, and an increasing number of consumer and technical applications.[1][2][3][4]

The binding **polymer** is often a **thermoset** resin such as **epoxy**, but other thermoset or **thermoplastic** polymers, such as **polyester**, **vinyl ester**, or **nylon**, are sometimes used.[4] The properties of the final CFRP product can be affected by the type of additives introduced to the binding matrix (resin). The most common additive is **silica**, but other additives such as rubber and **carbon nanotubes** can be used.

Carbon fiber is sometimes referred to as *graphite-reinforced polymer* or *graphite fiber-reinforced polymer* (*GFRP* is less common, as it clashes with **glass-(fiber)-reinforced polymer**).

Properties

[**edit**]

CFRP are **composite materials**. In this case the composite consists of two parts: a matrix and a reinforcement. In CFRP the reinforcement is carbon fiber, which provides its strength. The matrix is usually a thermosetting plastic, such as polyester resin, to bind the reinforcements together.[5] Because CFRPs consist of two distinct elements, the material properties depend on these two elements.

Reinforcement gives CFRPs their strength and rigidity, measured by **stress** and **elastic modulus** respectively. Unlike **isotropic** materials like steel and aluminum, CFRPs have directional strength properties. The properties of a CFRP depend on the layouts of the carbon fiber and the proportion of the carbon fibers relative to the polymer.[6] The two different equations governing the net elastic modulus of composite materials using the properties of the carbon fibers and the polymer matrix can also be applied to carbon fiber reinforced plastics.[7] The **rule of mixtures** for the equal **strain** case gives:

$$\displaystyle E_c=V_mE_m+V_fE_f$$

which is valid for composite materials with the fibers oriented **parallel** to the applied load. E_c is the total composite modulus, V_m and V_f are the volume fractions of the matrix and fiber respectively in the composite, and E_m and E_f are the elastic moduli of the matrix and fibers respectively.[7] The other extreme case of the elastic modulus of the composite with the fibers oriented transverse to the applied load can be found using the inverse rule of mixtures for the equal stress case:[7]

$$\displaystyle E_c=\left(\frac{V_m}{E_m}+\frac{V_f}{E_f}\right)^{-1}$$

The above equations give an upper and lower bound on the Young's modulus for CFRP and there are many other factors that influence the true value.

The fracture toughness of carbon fiber reinforced plastics is governed by multiple mechanisms:

- Debonding between the carbon fiber and polymer matrix.
- Fiber pull-out.
- Delamination between the CFRP sheets.[8]

Typical epoxy-based CFRPs exhibit virtually no plasticity, with less than 0.5% strain to failure. Although CFRPs with epoxy have high strength and elastic modulus, the brittle fracture mechanics presents unique challenges to engineers in failure detection since failure occurs catastrophically.[8] As such, recent efforts to toughen CFRPs include modifying the existing epoxy material and finding alternative polymer matrix. One such material with high promise is **PEEK**, which exhibits an order of magnitude greater toughness with similar elastic modulus and tensile strength.[8] However, PEEK is much more difficult to process and more expensive.[8]

Despite their high initial strength-to-weight ratios, a design limitation of CFRPs are their lack of a definable **fatigue limit**. This means, theoretically, that stress cycle failure cannot be ruled out. While steel and many other structural metals and alloys do have estimable fatigue or endurance limits, the complex failure modes of composites mean that the fatigue failure properties of CFRPs are difficult to predict and design against; however emerging research has shed light on the effects of low velocity impacts on composites.[9] Low velocity impacts can make carbon fiber polymers susceptible to damage.[9][10][11] As a result, when using CFRPs for critical cyclic-loading applications, engineers may need to design in considerable strength safety margins to provide suitable component reliability over its service life.

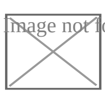
Environmental effects such as temperature and **humidity** can have profound effects on the polymer-based composites, including most CFRPs. While CFRPs demonstrate excellent corrosion resistance, the effect of moisture at wide ranges of temperatures can lead to degradation of the mechanical properties of CFRPs, particularly at the matrix-fiber interface.[12] While the carbon fibers themselves are not affected by the moisture diffusing into the material, the moisture plasticizes the polymer matrix.[8] This leads to significant changes in properties that are dominantly influenced by the matrix in CFRPs such as compressive, interlaminar shear, and impact properties.[13] The epoxy matrix used for engine fan blades is designed to be impervious against jet fuel, lubrication, and rain water, and external paint on the composites parts is applied to minimize damage from ultraviolet light.[8][14]

Carbon fibers can cause **galvanic corrosion** when CFRP parts are attached to aluminum or mild steel but not to stainless steel or titanium.[15]

CFRPs are very hard to machine, and cause significant tool wear. The tool wear in CFRP machining is dependent on the fiber orientation and machining condition of the cutting process. To reduce tool wear various types of coated tools are used in machining CFRP and CFRP-metal stack.[1]

Manufacturing

[**edit**]



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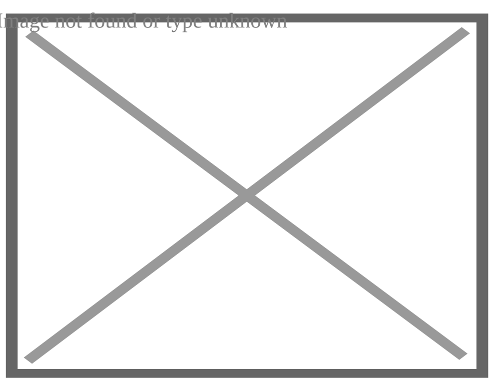


The primary element of CFRPs is a **carbon filament**; this is produced from a precursor **polymer** such as **polyacrylonitrile** (PAN), **rayon**, or petroleum **pitch**. For synthetic polymers such as PAN or rayon, the precursor is first **spun** into filament yarns, using chemical and mechanical processes to initially align the polymer chains in a way to enhance the final physical properties of the completed carbon fiber. Precursor compositions and mechanical processes used during spinning filament yarns may vary among manufacturers. After drawing or spinning, the polymer filament yarns are then heated to drive off non-carbon atoms (**carbonization**), producing the final carbon fiber. The carbon fibers filament yarns may be further treated to improve handling qualities, then wound onto **bobbins**.**[16]** From these fibers, a unidirectional sheet is created. These sheets are layered onto each other in a quasi-isotropic layup, e.g. 0°, +60°, or ?60° relative to each other.

From the elementary fiber, a bidirectional woven sheet can be created, i.e. a **twill** with a 2/2 weave. The process by which most CFRPs are made varies, depending on the piece being created, the finish (outside gloss) required, and how many of the piece will be produced. In addition, the choice of matrix can have a profound effect on the properties of the finished composite.**[17]**

Many CFRP parts are created with a single layer of carbon fabric that is backed with fiberglass.**[18]** A tool called a chopper gun is used to quickly create these composite parts. Once a thin shell is created out of carbon fiber, the chopper gun cuts rolls of fiberglass into short lengths and sprays resin at the same time, so that the fiberglass and resin are mixed on the spot.**[19]** The resin is either external mix, wherein the hardener and resin are sprayed separately, or internal mixed, which requires cleaning after every use. Manufacturing methods may include the following:

Molding

[**edit**]

One method of producing CFRP parts is by layering sheets of carbon fiber cloth into a **mold** in the shape of the final product. The alignment and weave of the cloth fibers is chosen to optimize the strength and stiffness properties of the resulting material. The mold is then filled with **epoxy** and is heated or air-cured. The resulting part is very corrosion-resistant, stiff, and strong for its weight. Parts used in less critical areas are manufactured by draping cloth over a mold, with epoxy either pre-impregnated into the fibers (also known as ***pre-preg***) or "painted" over it. High-performance parts using single molds are often vacuum-bagged and/or **autoclave**-cured, because even small air bubbles in the material will reduce strength. An alternative to the autoclave method is to use internal pressure via inflatable air bladders or **EPS foam** inside the non-cured laid-up carbon fiber.

Vacuum bagging

[**edit**]

For simple pieces of which relatively few copies are needed (one or two per day), a **vacuum bag** can be used. A fiberglass, carbon fiber, or aluminum mold is polished and waxed, and has a **release agent** applied before the fabric and resin are applied, and the vacuum is pulled and set aside to allow the piece to cure (harden). There are three ways to apply the resin to the fabric in a vacuum mold.

The first method is manual and called a wet layup, where the two-part resin is mixed and applied before being laid in the mold and placed in the bag. The other one is done by infusion, where the dry fabric and mold are placed inside the bag while the vacuum pulls the resin through a small tube into the bag, then through a tube with holes or something similar to evenly spread the resin throughout the fabric. Wire loom works perfectly for a tube that requires holes inside the bag. Both of these methods of applying resin require hand work to spread the resin evenly for a glossy finish with very small pin-holes.

A third method of constructing composite materials is known as a dry layup. Here, the carbon fiber material is already impregnated with resin (pre-preg) and is applied to the mold in a similar fashion to adhesive film. The assembly is then placed in a vacuum to cure. The dry layup method has the least amount of resin waste and can achieve lighter constructions than wet layup. Also, because larger amounts of resin are more difficult to bleed out with wet layup methods, pre-preg parts generally have fewer pinholes. Pinhole elimination with minimal resin amounts generally require the use of **autoclave** pressures to purge the residual gases out.

Compression molding

[**edit**]

A quicker method uses a **compression mold**, also commonly known as carbon fiber forging. This is a two (male and female), or multi-piece mold, usually made out of aluminum or steel and more recently 3D printed plastic. The mold components are pressed together with the fabric and resin loaded into the inner cavity that ultimately becomes the desired component. The benefit is the speed of the entire process. Some car manufacturers, such as BMW, claimed to be able to cycle a new part every 80 seconds. However, this technique has a very high initial cost since the molds require CNC machining of very high precision.

Filament winding

[**edit**]

For difficult or convoluted shapes, a **filament winder** can be used to make CFRP parts by winding filaments around a mandrel or a core.

Cutting

[edit]

Carbon fiber-reinforced pre-pregs and dry carbon fiber textiles require precise cutting methods to maintain material integrity and reduce defects such as fiber pull-out, delamination and fraying of the cutting edge. CNC digital cutting systems equipped with drag and oscillating are often used to cut carbon fiber pre-pregs, and rotating knives are commonly used to process carbon fiber fabrics. Ultrasonic cutting is another method to cut CFRP pre-pregs and is particularly effective in reducing delamination by minimizing mechanical stress during the cutting process. Waterjet cutting can be the preferred method for thicker and multilayered polymer composites.[20]

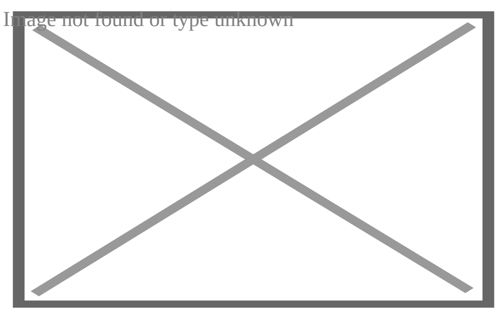
Applications

[edit]

Applications for CFRPs include the following:

Aerospace engineering

[edit]



An Airbus A350 with carbon fiber themed livery. Composite materials are used extensively throughout the A350.

The Airbus A350 XWB is 53% CFRP[21] including wing spars and fuselage components, overtaking the Boeing 787 Dreamliner, for the aircraft with the highest weight ratio for CFRP at 50%.[22] It was one of the first commercial aircraft to have wing spars made from composites. The Airbus A380 was one of the first commercial airliners to have a central wing-box made of CFRP and the first with a smoothly contoured wing cross-section instead of partitioning it span-wise into sections. This flowing, continuous cross section optimises aerodynamic efficiency.[*citation needed*] Moreover, the trailing edge, along with the rear bulkhead, empennage, and un-pressurised fuselage are made of CFRP.[23]

However, delays have pushed order delivery dates back because of manufacturing problems. Many aircraft that use CFRPs have experienced delays with delivery dates due to the relatively new processes used to make CFRP components, whereas metallic structures are better understood. A recurrent problem is the monitoring of structural ageing, for which new methods are required, due to the unusual multi-material and anisotropic[24][25][26] nature of CFRPs.[27]

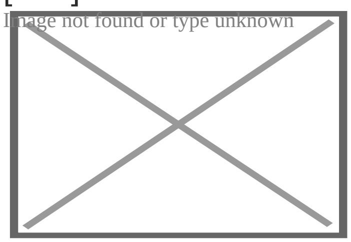
In 1968 a *Hyfil* carbon-fiber fan assembly was in service on the **Rolls-Royce Conways** of the **Vickers VC10s** operated by **BOAC**.[28]

Specialist aircraft designers and manufacturers **Scaled Composites** have made extensive use of CFRPs throughout their design range, including the first private crewed spacecraft **Spaceship One**. CFRPs are widely used in **micro air vehicles** (MAVs) because of their high strength-to-weight ratio.

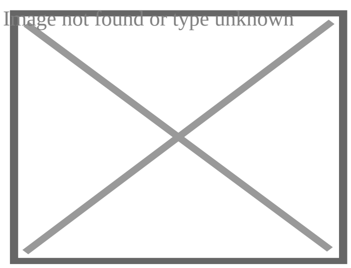
Airbus then moved to adopt CFRTP, because it can be reshaped and reprocessed after forming, can be manufactured faster, has higher impact resistance, is recyclable and remoldable, and has lower processing costs.[29]

Automotive engineering

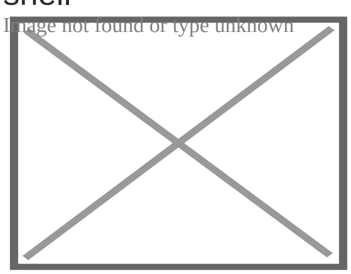
[**edit**]



Citroën SM that won 1971 **Rally of Morocco** with carbon fiber wheels



1996 **McLaren F1** – first carbon fiber body shell



McLaren MP4 (MP4/1),
first carbon fiber F1 car

CFRPs are extensively used in high-end automobile racing.[30] The high cost of carbon fiber is mitigated by the material's unsurpassed strength-to-weight ratio, and low weight is essential for high-performance automobile racing. Race-car manufacturers have also developed methods to give carbon fiber pieces strength in a certain direction, making it strong in a load-bearing direction, but weak in directions where little or no load would be placed on the member. Conversely, manufacturers developed omnidirectional carbon fiber weaves that apply strength in all directions. This type of carbon fiber assembly is most widely used in the "safety cell" **monocoque** chassis assembly of high-performance race-cars. The first carbon fiber monocoque chassis was introduced in **Formula One** by **McLaren** in the 1981 season. It was designed by **John Barnard** and was widely copied in the following seasons by other F1 teams due to the extra rigidity provided to the chassis of the cars.[31]

Many **supercars** over the past few decades have incorporated CFRPs extensively in their manufacture, using it for their monocoque chassis as well as other components.[32] As far back as 1971, the **Citroën SM** offered optional lightweight carbon fiber wheels.[33][34]

Use of the material has been more readily adopted by low-volume manufacturers who used it primarily for creating body-panels for some of their high-end cars due to its increased strength and decreased weight compared with the **glass-reinforced polymer** they used for the majority of their products.

Civil engineering

[**edit**]
Further information: **Structural applications of FRP**

CFRPs have become a notable material in **structural engineering** applications. Studied in an academic context as to their potential benefits in construction, CFRPs have also proved themselves cost-effective in a number of field applications strengthening concrete, masonry, steel, cast iron, and timber structures. Their use in industry can be either for **retrofitting** to strengthen an existing structure or as an alternative reinforcing (or prestressing) material instead of steel from the outset of a project.

Retrofitting has become the increasingly dominant use of the material in civil engineering, and applications include increasing the load capacity of old structures (such as bridges, beams, ceilings, columns and walls) that were designed to tolerate far lower service loads than they are experiencing today, seismic retrofitting, and repair of damaged structures. Retrofitting is popular in many instances as the cost of replacing the deficient structure can greatly exceed the cost of strengthening using CFRP.[35]

Applied to reinforced concrete structures for flexure, the use of CFRPs typically has a large impact on strength (doubling or more the strength of the section is not uncommon), but only moderately increases **stiffness** (as little as 10%). This is because the material used in such applications is typically very strong (e.g., 3 GPa ultimate **tensile strength**, more than 10 times mild steel) but not particularly stiff (150 to 250 GPa elastic modulus, a little less than steel, is typical). As a consequence, only small cross-sectional areas of the material are used. Small areas of very high strength but moderate stiffness material will significantly increase strength, but not stiffness.

CFRPs can also be used to enhance **shear strength** of reinforced concrete by wrapping fabrics or fibers around the section to be strengthened. Wrapping around sections (such as bridge or building columns) can also enhance the **ductility** of the section, greatly increasing the resistance to collapse under dynamic loading. Such 'seismic retrofit' is the major application in earthquake-prone areas, since it is much more economic than alternative methods.

If a column is circular (or nearly so) an increase in axial capacity is also achieved by wrapping. In this application, the confinement of the CFRP wrap enhances the **compressive strength** of the concrete. However, although large increases are achieved in the ultimate collapse load, the concrete will crack at only slightly enhanced load, meaning that this application is only occasionally used. Specialist ultra-high modulus CFRP (with tensile modulus of 420 GPa or more) is one of the few practical methods of strengthening **cast iron** beams. In typical use, it is bonded to the tensile flange of the section, both increasing the stiffness of the section and lowering the **neutral axis**, thus greatly reducing the maximum tensile stress in the cast iron.

In the United States, **prestressed concrete** cylinder pipes (PCCP) account for a vast majority of water transmission mains. Due to their large diameters, failures of PCCP are usually catastrophic and affect large populations. Approximately 19,000 miles (31,000 km) of PCCP were installed between 1940 and 2006. **Corrosion** in the form of hydrogen embrittlement has been blamed for the gradual deterioration of the prestressing wires in many PCCP lines. Over the past decade, CFRPs have been used to internally line PCCP, resulting in a fully structural strengthening system. Inside a PCCP line, the CFRP liner acts as a barrier that controls the level of strain experienced by the steel cylinder in the host pipe. The composite liner enables the steel cylinder to perform within its elastic range, to ensure the pipeline's long-term performance is maintained. CFRP liner designs are based on strain compatibility between the liner and host pipe.[36]

CFRPs are more costly materials than commonly used their counterparts in the construction industry, **glass fiber-reinforced polymers** (GFRPs) and **aramid** fiber-reinforced polymers (AFRPs), though CFRPs are, in general, regarded as having superior properties. Much research continues to be done on using CFRPs both for retrofitting and as an alternative to steel as reinforcing or prestressing materials. Cost remains an issue and long-term **durability** questions still remain. Some are concerned about the **brittle** nature of CFRPs, in contrast to the ductility of steel. Though design codes have been drawn up by institutions such as the **American Concrete Institute**, there remains some hesitation among the engineering community about implementing these alternative materials. In part, this is due to a lack of standardization and the proprietary nature of the fiber and resin combinations on the market.

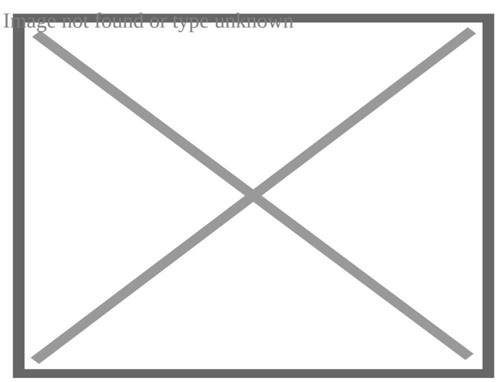
Carbon-fiber microelectrodes

[**edit**]

Carbon fibers are used for fabrication of carbon-fiber **microelectrodes**. In this application typically a single carbon fiber with diameter of 5–7 ?m is sealed in a glass capillary.**[37]** At the tip the capillary is either sealed with epoxy and polished to make carbon-fiber disk microelectrode or the fiber is cut to a length of 75–150 ?m to make carbon-fiber cylinder electrode. Carbon-fiber microelectrodes are used either in **amperometry** or **fast-scan cyclic voltammetry** for detection of biochemical signalling.

Sports goods

[**edit**]



A carbon-fiber and **Kevlar** canoe (Placid Boatworks Rapidfire at the **Adirondack Canoe Classic**)

CFRPs are now widely used in sports equipment such as in squash, tennis, and badminton racquets, **sport kite** spars, high-quality arrow shafts, hockey sticks, fishing rods, **surfboards**, high end swim fins, and rowing **shells**. Amputee athletes such as **Jonnie Peacock** use carbon fiber blades for running. It is used as a shank plate in some **basketball** sneakers to keep the foot stable, usually running the length of the shoe just above the sole and left exposed in some areas, usually in the arch.

Controversially, in 2006, cricket bats with a thin carbon-fiber layer on the back were introduced and used in competitive matches by high-profile players including **Ricky Ponting** and **Michael Hussey**. The carbon fiber was claimed to merely increase the durability of the bats, but it was banned from all first-class matches by the **ICC** in 2007.**[38]**

A CFRP **bicycle frame** weighs less than one of steel, aluminum, or **titanium** having the same strength. The type and orientation of the carbon-fiber weave can be designed to maximize stiffness in required directions. Frames can be tuned to address different riding styles: sprint events require stiffer frames while endurance events may require more flexible frames for rider comfort over longer periods.[39] The variety of shapes it can be built into has further increased stiffness and also allowed **aerodynamic** tube sections. CFRP **forks** including suspension fork crowns and steerers, **handlebars**, **seatposts**, and **crank arms** are becoming more common on medium as well as higher-priced bicycles. CFRP **rims** remain expensive but their stability compared to aluminium reduces the need to re-true a wheel and the reduced mass reduces the **moment of inertia** of the wheel. CFRP spokes are rare and most carbon wheelsets retain traditional stainless steel spokes. CFRPs also appear increasingly in other components such as derailleur parts, brake and shifter levers and bodies, cassette sprocket carriers, suspension linkages, disc brake rotors, pedals, shoe soles, and saddle rails. Although strong and light, impact, over-torquing, or improper installation of CFRP components has resulted in cracking and failures, which may be difficult or impossible to repair.[40][41]

Other applications

[**edit**]

Dunlop "Max-Grip" carbon fiber guitar picks. Sizes 1mm and Jazz III.

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Dunlop "Max-Grip" carbon fiber guitar picks. Sizes 1mm and Jazz III.

The fire resistance of polymers and thermo-set composites is significantly improved if a thin layer of carbon fibers is moulded near the surface because a dense, compact layer of carbon fibers efficiently reflects heat.[42]

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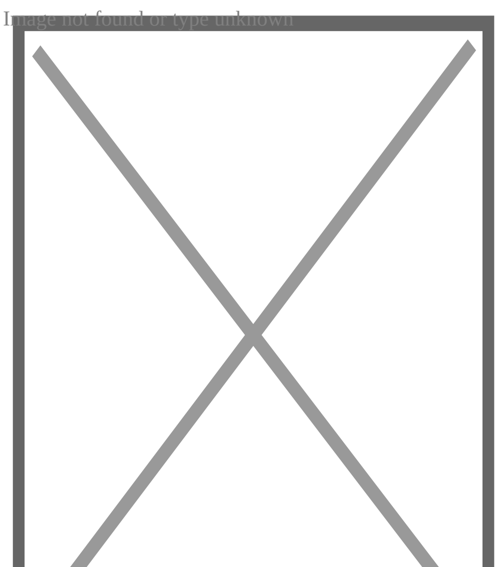

Strandberg Boden Plini **neck-thru** & **bolt on** versions that both utilize carbon fiber reinforcement strips to maintain rigidity.

CFRPs are being used in an increasing number of high-end products that require stiffness and low weight, these include:

- Musical instruments, including violin bows; guitar picks, guitar necks (fitted with carbon fiber rods), **pickguards**/scratchplates; drum shells; bagpipe chanters; piano actions; and entire musical instruments such as carbon fiber cellos, violas, and violins, acoustic guitars and ukuleles; also, audio components such as turntables and loudspeakers.
- Firearms use it to replace certain metal, wood, and fiberglass components but many of the internal parts are still limited to metal alloys as current reinforced plastics are unsuitable.
- High-performance drone bodies and other radio-controlled vehicle and aircraft components such as helicopter rotor blades.
- Lightweight poles such as: tripod legs, tent poles, fishing rods, billiards cues, walking sticks, and high-reach poles such as for window cleaning.
- Dentistry, **carbon fiber posts** are used in restoring root canal treated teeth.
- Railed train **bogies** for passenger service. This reduces the weight by up to 50% compared to metal bogies, which contributes to energy savings.**[43]**
- Laptop shells and other high performance cases.
- Carbon woven fabrics.**[44][45]**
- Archery: carbon fiber arrows and bolts, **stock** (for crossbows) and **riser** (for vertical bows), and rail.
- As a filament for the 3D fused deposition modeling printing process,**[46]** carbon fiber-reinforced plastic (polyamide-carbon filament) is used for the production of sturdy but lightweight tools and parts due to its high strength and tear length.**[47]**
- District heating pipe rehabilitation, using a **CIPP** method.

Disposal and recycling

[**edit**]

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The key aspect of recycling fiber-reinforced polymers is preserving their mechanical properties while successfully recovering both the **thermoplastic** matrix and the reinforcing fibers. CFRPs have a long service lifetime when protected from the sun. When it is time to decommission CFRPs, they cannot be melted down in air like many metals. When free of vinyl (PVC or **polyvinyl chloride**) and other halogenated polymers, CFRPs recycling processes can be categorized into four main approaches: mechanical, **thermal**, chemical, and biological. Each method offers distinct advantages in terms of material or **energy recovery**, contributing to **sustainability** efforts in composite waste management.

Process	Matrix recovery	Fiber recovery	Degradation of Mechanical Properties	Advantages/Drawbacks
Mechanical	X	X	X	+No use of hazardous chemical substances +No gas emissions +Low-cost energy needed +Big volumes can be recycled -Poor bonding between fiber/matrix -Fibers can damage the equipment
Chemical		X		+Long clean fibers +Retention of mechanical properties +Sometimes there is high recovery of the matrix -Expensive equipment -Possible use of hazardous solvent
Thermal		X	X	+Fiber length retention +No use of hazardous chemical substances +better mechanical properties than mechanical approach +Matrix used to produce energy -Recovered fiber properties highly influenced by process parameters -some processes have no recovery of matrix material

Mechanical Recycling

[**edit**]

The mechanical process primarily involves **grinding**, which breaks down composite materials into pulverulent charges and fibrous reinforcements. This method is focused on both the thermoplastic and filler material recovery; however, this process shortens the fibers dramatically. Just as with **downcycled** paper, the shortened fibers cause the recycled material to be weaker than the original material. There are still many industrial applications that do not need the strength of full-length carbon fiber reinforcement. For example, chopped reclaimed carbon fiber can be used in consumer electronics, such as laptops. It provides excellent reinforcement of the polymers used even if it lacks the strength-to-weight ratio of an aerospace component.**[48]**

Electro fragmentation

[edit]

This method consists in shredding CFRP by pulsed **electrical discharges**. Initially developed to extract crystals and precious stones from mining rocks, it is now expected to be developed for composites. The material is placed in a vessel containing water and two **electrodes**. The high voltage electrical pulse generated between the electrodes (50-200 kV) fragments the material into smaller pieces.[49] The inconvenient of this technique is that the energy consumed is 2.6 times the one of a mechanical route making it not economically competitive in terms of energy saving and needs further investigation.

Thermal Recycling

[edit]

Thermal processes include several techniques such as **incineration**, **thermolysis**, **pyrolysis**, **gasification**, fluidized bed processing, and **cement plant** utilization. This processes imply the recovery of the fibers by the removal of the **resin** by volatilizing it, leading to by-products such as gases, liquids or inorganic matter.[50]

Oxidation in fluidized bed

[edit]

This technique consists in exposing the composite to a hot and **oxygen-rich** flow, in which it is combusted (450–550 °C, 840–1,020 °F) . The working temperature is selected in function of the matrix to be **decomposed**, to limit damages of the fibers. After a shredding step to 6-20 mm size, the composite is introduced into a bed of **silica sand**, on a metallic mesh, in which the resin will be decomposed into oxidized molecules and fiber filaments. These components will be carried up with the air stream while heavier particles will sink in the bed. This last point is a great advantage for contaminated end-of-life products, with painted surfaces, **foam cores** or metal insert. A **cyclone** enables the recovery of fibers of length ranging between 5 and 10 mm and with very little contamination . The matrix is fully oxidized in a second burner operating at approximatively 1,000 °C (1,850 °F) leading to **energy recovery** and a clean flue gas.[51]

Chemical Recycling

[edit]

The chemical recycling of CFRPs involves using a reactive **solvent** at relatively low temperatures (below 350°C) to break down the resin while leaving the fibers intact for reuse. The solvent degrades the composite matrix into smaller molecular fragments (**oligomer**), and depending on the chosen solvent system, various processing parameters such as temperature, pressure, and **catalysts** can be adjusted to optimize the process. The solvent, often combined with **co-solvents** or catalysts, penetrates the composite and **breaks specific chemical bonds**, resulting in recovered **monomers** from the resin and clean, long fibers with preserved mechanical properties. The required temperature and pressure depend on the type of resin, with **epoxy resins** generally needing higher temperatures than polyester resins. Among the different reactive mediums studied, water is the most commonly used due to its environmental benefits. When combined with **alkaline** catalysts, it effectively degrades many resins, while **acidic** catalysts are used for more resistant polymers. Other solvents, such as **ethanol**, **acetone**, and their mixtures, have also been explored for this process.

Despite its advantages, this method has some limitations. It requires specialized equipment capable of handling **corrosive** solvents, hazardous chemicals, and high temperatures or pressures, especially when operating under **supercritical** conditions. While extensively researched at the laboratory scale, industrial adoption remains limited, with the technology currently reaching a **Technology Readiness Level** (TRL) of 4 for carbon fiber recycling.[52]

Dissolution Process

[**edit**]

The dissolution process is a method used to recover both the polymer matrix and fibers from thermoplastic composites without breaking **chemical bonds**. Unlike **solvolysis**, which involves the **chemical degradation** of the polymer, dissolution simply dissolves the polymer chains into a solvent, allowing for material recovery in its original form. An energy analysis of the process indicated that dissolution followed by **evaporation** was more energy-efficient than **precipitation**. Additionally, avoiding precipitation helped minimize polymer loss, improving overall material recovery efficiency. This method offers a promising approach for sustainable recycling of thermoplastic composites.[53]

Biological Recycling

[**edit**]

The biological process, though still under development, focuses on **biodegradation** and **composting**. This method holds promise for bio-based and agro-composites, aiming to create an environmentally friendly end-of-life solution for these materials. As research advances, biological recycling may offer an effective means of reducing plastic composite waste in a sustainable manner.[54]

Carbon nanotube reinforced polymer (CNRP)

[edit]

In 2009, **Zyvex Technologies** introduced carbon nanotube-reinforced epoxy and carbon **pre-pregs**.[55] **Carbon nanotube** reinforced polymer (CNRP) is several times stronger and tougher than typical CFRPs and is used in the **Lockheed Martin F-35 Lightning II** as a structural material for aircraft.[56] CNRP still uses carbon fiber as the primary reinforcement,[57] but the binding matrix is a carbon nanotube-filled epoxy.[58]

See also

[edit]

- **Carbon fibers** – Material fibers about 5–10 ?m in diameter composed of carbon
- **Composite repair** – Composite repair patch preparation and application
- **Mechanics of Oscar Pistorius's running blades** – Blades used by South African Paralympic runner Oscar Pistorius
- **Reinforced carbon–carbon** – Graphite-based composite material
- **Forged carbon fiber**
- **Carbon-ceramic**
- **Carbotanium**

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A wooden pier in Corfu, Greece

A **pier** is a raised structure that rises above a body of water and usually juts out from its shore, typically supported by piles or pillars, and provides above-water access to offshore areas. Frequent pier uses include fishing, boat docking and access for both passengers and cargo, and oceanside recreation. Bridges, buildings, and walkways may all be supported by architectural piers. Their open structure allows tides and currents to flow relatively unhindered, whereas the more solid foundations of a quay or the closely spaced piles of a wharf can act as a breakwater, and are consequently more liable to silting. Piers can range in size and complexity from a simple lightweight wooden structure to major structures extended over 1,600 m (5,200 ft). In American English, a pier may be synonymous with a dock.

Piers have been built for several purposes, and because these different purposes have distinct regional variances, the term *pier* tends to have different nuances of meaning in different parts of the world. Thus in North America and Australia, where many ports were, until recently, built on the multiple pier model, the term tends to imply a current or former cargo-handling facility. In contrast, in Europe, where ports more often use basins and river-side quays than piers, the term is principally associated with the image of a Victorian cast iron pleasure pier which emerged in Great Britain during the early 19th century. However, the earliest piers pre-date the Victorian age.

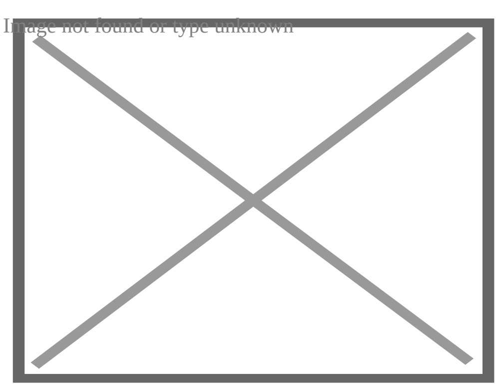
Types

[edit]

Piers can be categorized into different groupings according to the principal purpose.[1] However, there is considerable overlap between these categories. For example, pleasure piers often also allow for the docking of pleasure steamers and other similar craft, while working piers have often been converted to leisure use after being rendered obsolete by advanced developments in cargo-handling technology. Many piers are floating piers, to ensure that the piers raise and lower with the tide along with the boats tied to them. This prevents a situation where lines become overly taut or loose by rising or lowering tides. An overly taut or loose tie-line can damage boats by pulling them out of the water or allowing them so much leeway that they bang forcefully against the sides of the pier.

Working piers

[edit]



Out-of-use industrial bulk cargo Pier, Cook Inlet, Alaska.

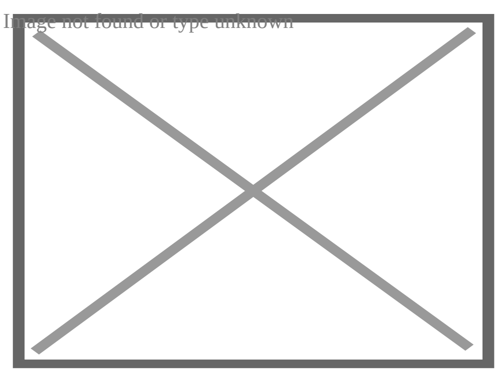
Working piers were built for the handling of passengers and cargo onto and off ships or (as at Wigan Pier) canal boats. Working piers themselves fall into two different groups. Longer individual piers are often found at ports with large tidal ranges, with the pier stretching far enough off shore to reach deep water at low tide. Such piers provided an economical alternative to impounded docks where cargo volumes were low, or where specialist bulk cargo was handled, such as at coal piers. The other form of working pier, often called the finger pier, was built at ports with smaller tidal ranges. Here the principal advantage was to give a greater available quay length for ships to berth against compared to a linear littoral quayside, and such piers are usually much shorter. Typically each pier would carry a single transit shed the length of the pier, with ships berthing bow or stern in to the shore. Some major ports consisted of large numbers of such piers lining the foreshore, classic examples being the Hudson River frontage of New York, or the Embarcadero in San Francisco.

The advent of container shipping, with its need for large container handling spaces adjacent to the shipping berths, has made working piers obsolete for the handling of general cargo, although some still survive for the handling of passenger ships or bulk cargos. One example, is in use in Progreso, Yucatán, where a pier extends more than 4 miles into the Gulf of Mexico, making it the longest pier in the world. The Progreso Pier supplies much of the peninsula with transportation for the fishing and cargo industries and serves as a port for large cruise ships in the area. Many other working piers have been demolished, or remain derelict, but some have been recycled as pleasure piers. The best known example of this is Pier 39 in San Francisco.

At Southport and the Tweed River on the Gold Coast in Australia, there are piers that support equipment for a sand bypassing system that maintains the health of sandy beaches and navigation channels.

Pleasure piers

[edit]



Print of a Victorian pier in Margate in the English county of Kent, 1897

Pleasure piers were first built in Britain during the early 19th century.[2] The earliest structures were Ryde Pier, built in 1813/4, Trinity Chain Pier near Leith, built in 1821, Brighton Chain Pier, built in 1823.[2] and Margate Jetty 1823/24 originally a timber built pier.

Only the oldest of these piers still remains. At that time, the introduction of steamships and railways for the first time permitted mass tourism to dedicated seaside resorts. The large tidal ranges at many such resorts meant that passengers arriving by pleasure steamer could use a pier to disembark safely.[3] Also, for much of the day, the sea was not visible from the shore and the pleasure pier permitted holidaymakers to promenade over and alongside the sea at all times.[4] The world's longest pleasure pier is at Southend-on-Sea, Essex, and extends 1.3 miles (2.1 km) into the Thames Estuary.[2] The longest pier on the West Coast of the US is the Santa Cruz Wharf, with a length of 2,745 feet (837 m).[5]

Providing a walkway out to sea, pleasure piers often include amusements and theatres as part of their attractions.[4] Such a pier may be unroofed, closed, or partly open and partly closed. Sometimes a pier has two decks. Galveston Island Historic Pleasure Pier in Galveston, Texas has a roller coaster, 15 rides, carnival games and souvenir shops.[6]

Early pleasure piers were of complete timber construction, as was with Margate which opened in 1824. The first iron and timber built pleasure pier Margate Jetty, opened in 1855.[7] Margate pier was wrecked by a storm in January 1978 and not repaired.[8][7] The longest iron pleasure pier still remaining is the one at Southend. First opened as a wooden pier in 1829, it was reconstructed in iron and completed in 1889. In a 2006 UK poll, the public voted the seaside pier onto the list of icons of England.[9]

Fishing piers

[edit]

Many piers are built for the purpose of providing boatless anglers access to fishing grounds that are otherwise inaccessible.[10] Many "Free Piers" are available in larger harbors which differ from private piers. Free Piers are often primarily used for fishing. Fishing from a pier presents a set of different circumstances to fishing from the shore or beach, as you do not need to cast out into the deeper water. This being the case there are specific fishing rigs that have been created specifically for pier fishing[11] which allow for the direct access to deeper water.

Piers of the world

[edit]
Main article: List of piers

Belgium

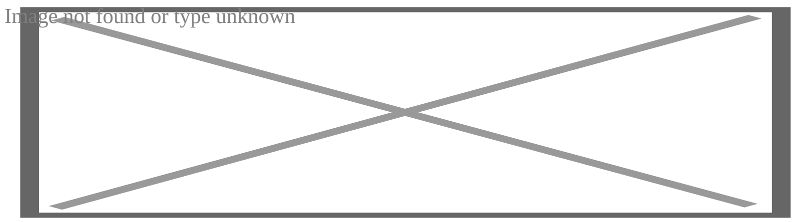
[edit]

In Blankenberge a first pleasure pier was built in 1894. After its destruction in the World War I, a new pier was built in 1933. It remained till the present day, but was partially transformed and modernized in 1999–2004.

In Nieuwpoort, Belgium there is a pleasure pier on both sides of the river IJzer.

Netherlands

[edit]



The Scheveningen Pier

Scheveningen, the coastal resort town of The Hague, boasts the largest pier in the Netherlands, completed in 1961. A crane, built on top of the pier's panorama tower, provides the opportunity to make a 60-metre (200 ft) high bungee jump over the North Sea waves. The present pier is a successor of an earlier pier, which was completed in 1901 but in 1943 destroyed by the German occupation forces.

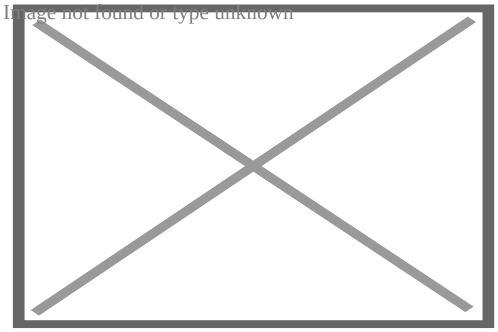
United Kingdom

[edit]

England and Wales

[edit]

The first recorded pier in England was Ryde Pier, opened in 1814 on the Isle of Wight, as a landing stage to allow ferries to and from the mainland to berth. It is still used for this purpose today.[12] It also had a leisure function in the past, with the pier head once containing a pavilion, and there are still refreshment facilities today. The oldest cast iron pier in the world is Town Pier, Gravesend, in Kent, which opened in 1834. However, it is not recognised by the National Piers Society as being a seaside pier.[13]



Brighton Palace Pier (pictured in 2011), opened in 1899

Following the building of the world's first seaside pier at Ryde, the pier became fashionable at seaside resorts in England and Wales during the Victorian era, peaking in the 1860s with 22 being built in that decade.[14] A symbol of the typical British seaside holiday, by 1914, more than 100 pleasure piers were located around the UK coast.[2] Regarded as being among the finest Victorian architecture, there are still a significant number of seaside piers of architectural merit still standing, although some have been lost, including Margate, two at Brighton in East Sussex, one at New Brighton in the Wirral and three at Blackpool in Lancashire.[4] Two piers, Brighton's now derelict West Pier and Clevedon Pier, were Grade 1 listed. The Birnbeck Pier in Weston-super-Mare is the only pier in the world linked to an island. The National Piers Society gives a figure of 55 surviving seaside piers in England and Wales.[1] In 2017, Brighton Palace Pier was said to be the most visited tourist attraction outside London, with over 4.5 million visitors the previous year.[15]

See also

[edit]

- Boardwalk
- Breakwater
- Dock
- Jetty
- List of piers
- Seaside resort
- Wharf

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External links

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- The Piers Project
- National Piers Society
- Details on UK Piers including Webcams

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About Pile driver

This article is about the mechanical device used in construction. For other uses, see Pile driver (disambiguation).

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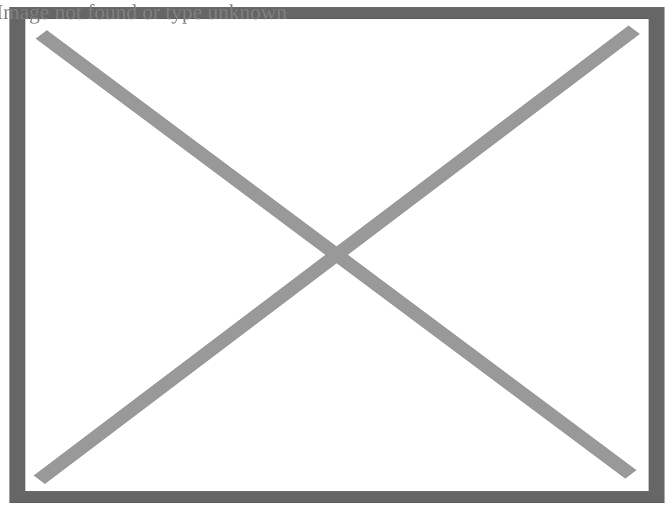


Tracked vehicle configured as a dedicated pile driver

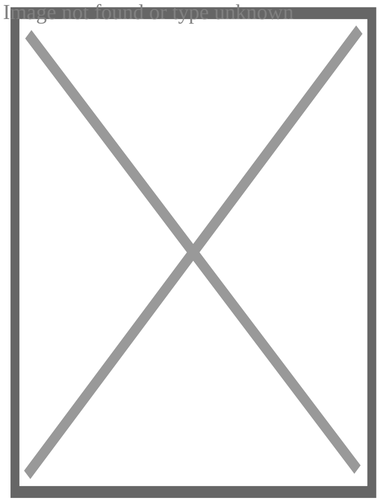
A **pile driver** is a heavy-duty tool used to drive piles into soil to build piers, bridges, cofferdams, and other "pole" supported structures, and patterns of pilings as part of permanent deep foundations for buildings or other structures. Pilings may be made of wood, solid steel, or tubular steel (often later filled with concrete), and may be driven entirely underwater/underground, or remain partially aboveground as elements of a finished structure.

The term "pile driver" is also used to describe members of the construction crew associated with the task,[1] also colloquially known as "pile bucks".[2]

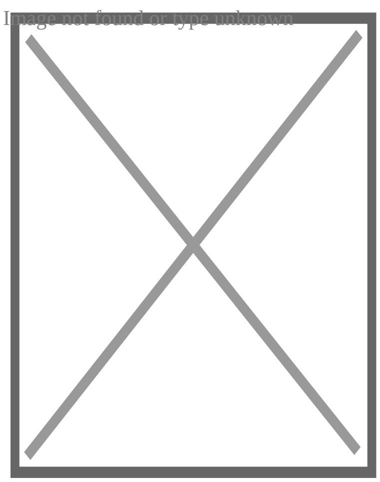
The most common form of pile driver uses a heavy weight situated between vertical guides placed above a pile. The weight is raised by some motive power (which may include hydraulics, steam, diesel, electrical motor, or manual labor). At its apex the weight is released, impacting the pile and driving it into the ground.[1][3]

History

[edit]



Replica of Ancient Roman pile driver used at the construction of Caesar's Rhine bridges (55 BC)



18th-century Pile driver, from *Abhandlung vom Wasserbau an Strömen*, 1769

There are a number of claims to the invention of the pile driver. A mechanically sound drawing of a pile driver appeared as early as 1475 in Francesco di Giorgio Martini's treatise *Trattato di Architectura*.[4] Also, several other prominent inventors—James Nasmyth (son of Alexander Nasmyth), who invented a steam-powered pile driver in 1845,[5] watchmaker James Valoué,[6] Count Giovan Battista Gazzola,[7] and Leonardo da Vinci[8]—have all been credited with inventing the device. However, there is evidence that a comparable device was used in the construction of Crannogs at Oakbank and Loch Tay in Scotland as early as 5000 years ago.[9] In 1801 John Rennie came up with a steam pile driver in Britain.[10] Otis Tufts is credited with inventing the steam pile driver in the United States.[11]

Types

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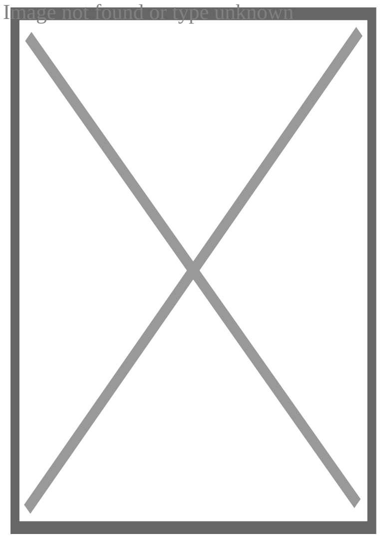

Pile driver, 1917

Ancient pile driving equipment used human or animal labor to lift weights, usually by means of pulleys, then dropping the weight onto the upper end of the pile. Modern piledriving equipment variously uses hydraulics, steam, diesel, or electric power to raise the weight and guide the pile.

Diesel hammer

[edit]

Concrete spun pile driving using diesel hammer in Patimban Deep Sea Port, Indonesia

A modern diesel pile hammer is a large two-stroke diesel engine. The weight is the piston, and the apparatus which connects to the top of the pile is the cylinder. Piledriving is started by raising the weight; usually a cable from the crane holding the pile driver — This draws air into the cylinder. Diesel fuel is injected into the cylinder. The weight is dropped, using a quick-release. The weight of the piston compresses the air/fuel mixture, heating it to the ignition point of diesel fuel. The mixture ignites, transferring the energy of the falling weight to the pile head, and driving the weight up. The rising weight draws in fresh air, and the cycle continues until the fuel is depleted or is halted by the crew.[12]

From an army manual on pile driving hammers: The initial start-up of the hammer requires that the piston (ram) be raised to a point where the trip automatically releases the piston, allowing it to fall. As the piston falls, it activates the fuel pump, which discharges a metered amount of fuel into the ball pan of the impact block. The falling piston blocks the exhaust ports, and compression of fuel trapped in the cylinder begins. The compressed air exerts a pre-load force to hold the impact block firmly against the drive cap and pile. At the bottom of the compression stroke, the piston strikes the impact block, atomizing the fuel and starting the pile on its downward movement. In the instant after the piston strikes, the atomized fuel ignites, and the resulting explosion exerts a greater force on the already moving pile, driving it further into the ground. The reaction of the explosion rebounding from the resistance of the pile drives the piston upward. As the piston rises, the exhaust ports open, releasing the exhaust gases to the atmosphere. After the piston stops its upward movement, it again falls by gravity to start another cycle.

Vertical travel lead systems

[edit]

Berminghammer vertical travel leads in use

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Military building mobile unit on "Army-2021" exhibition

Vertical travel leads come in two main forms: spud and box lead types. Box leads are very common in the Southern United States and spud leads are common in the Northern United States, Canada and Europe.

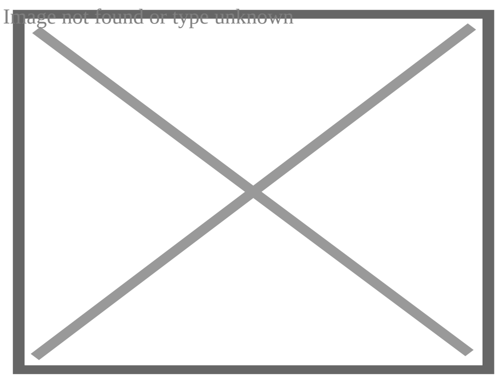
Hydraulic hammer

[edit]

A hydraulic hammer is a modern type of piling hammer used instead of diesel and air hammers for driving steel pipe, precast concrete, and timber piles. Hydraulic hammers are more environmentally acceptable than older, less efficient hammers as they generate less noise and pollutants. In many cases the dominant noise is caused by the impact of the hammer on the pile, or the impacts between components of the hammer, so that the resulting noise level can be similar to diesel hammers.[12]

Hydraulic press-in

[edit]



A steel sheet pile being hydraulically pressed

Hydraulic press-in equipment installs piles using hydraulic rams to press piles into the ground. This system is preferred where vibration is a concern. There are press attachments that can adapt to conventional pile driving rigs to press 2 pairs of sheet piles simultaneously. Other types of press equipment sit atop existing sheet piles and grip previously driven piles. This system allows for greater press-in and extraction force to be used since more reaction force is developed.[12] The reaction-based machines operate at only 69 dB at 23 ft allowing for installation and extraction of piles in close proximity to sensitive areas where traditional methods may threaten the stability of existing structures.

Such equipment and methods are specified in portions of the internal drainage system in the New Orleans area after Hurricane Katrina, as well as projects where noise, vibration and access are a concern.

Vibratory pile driver/extractor

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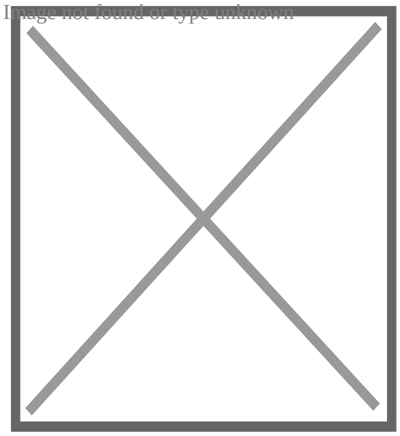

A diesel-powered vibratory pile driver on a steel I-beam

Vibratory pile hammers contain a system of counter-rotating eccentric weights, powered by hydraulic motors, and designed so that horizontal vibrations cancel out, while vertical vibrations are transmitted into the pile. The pile driving machine positioned over the pile with an excavator or crane, and is fastened to the pile by a clamp and/or bolts. Vibratory hammers can drive or extract a pile. Extraction is commonly used to recover steel I-beams used in temporary foundation shoring. Hydraulic fluid is supplied to the driver by a diesel engine-powered pump mounted in a trailer or van, and connected to the driver head via hoses. When the pile driver is connected to a dragline excavator, it is powered by the excavator's diesel engine. Vibratory pile drivers are often chosen to mitigate noise, as when the construction is near residences or office buildings, or when there is insufficient vertical clearance to permit use of a conventional pile hammer (for example when retrofitting additional piles to a bridge column or abutment footing). Hammers are available with several different vibration rates, ranging from 1200 vibrations per minute to 2400 VPM. The vibration rate chosen is influenced by soil conditions and other factors, such as power requirements and equipment cost.

Piling rig

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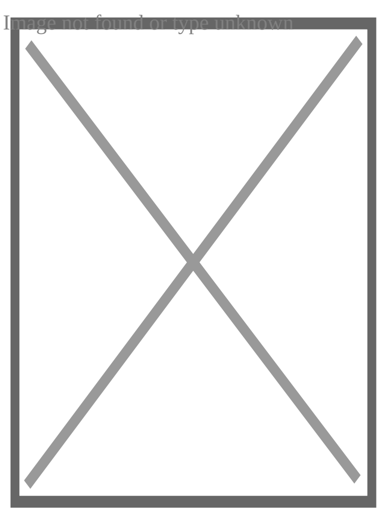

A Junttan purpose-built piledriving rig in Jyväskylä, Finland

A piling rig is a large track-mounted drill used in foundation projects which require drilling into sandy soil, clay, silty clay, and similar environments. Such rigs are similar in function to oil drilling rigs, and can be equipped with a short screw (for dry soil), rotary bucket (for wet soil) or core drill (for rock), along with other options. Expressways, bridges, industrial and civil buildings, diaphragm walls, water conservancy projects, slope protection, and seismic retrofitting are all projects which may require piling rigs.

Environmental effects

[edit]

The underwater sound pressure caused by pile-driving may be deleterious to nearby fish.[13][14] State and local regulatory agencies manage environment issues associated with pile-driving.[15] Mitigation methods include bubble curtains, balloons, internal combustion water hammers.[16]

See also

[edit]

- Auger (drill)
- Deep foundation
- Post pounder
- Drilling rig

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[edit]

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External links

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Wikimedia Commons has media related to ***Pile drivers***.

- Website about Vulcan Iron Works, which produced pile drivers from the 1870s through the 1990s

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United Structural Systems of Illinois, Inc

Phone : +18473822882

City : Hoffman Estates

State : IL

Zip : 60169

Address : 2124 Stonington Ave

Google Business Profile

Company Website : **https://www.unitedstructuralsystems.com/**

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