Making Concrete Design

The Guideline by Sven Backstein

Imprint

Guideline to Making Concrete Design

Images, texts, typesetting and layout: Sven Backstein

ISBN 978-3-943039-05-4

Legal notice:

RHEINGOLDVERLAG
BONN

Sven Backstein

Guideline

Making Concrete Design

Why Concrete?

Concrete is not only a building material, but also an incredibly versatile material for artists and designers. It offers a wealth of design possibilities that make it increasingly attractive as an alternative to wood, ceramics and metal. The inexpensive availability of a large number of special prefabricated materials allows the creation of objects of almost any size, from small utilitarian and decorative objects to large sculptures.

The whale house is a play and climbing object made of concrete. It was made of GRUMO basic mortar using the spraying technique and is lined with mosaic on the inside..

What Is Concrete?

Concrete is an artificially produced stone made of cement, water and aggregates (sand or gravel). Instead of the aggregates, special concrete formulations can also contain other additives, such as wood chips, porous lightweight aggregates, hollow spheres or simply air. This is then referred to as wood chip concrete, lightweight concrete or concrete foam.

The term mortar is also used synonymously with the term concrete. It is particularly common for wall plastering compounds or fine-grained grouting compounds. However, the distinction between the terms has no further significance with regard to practical use.

How Concrete Works

As already mentioned, concrete consists of three components: water, cement and aggregate. The two components water and cement form the so-called cement paste. The third component (sand, gravel or other aggregates) is called aggregate. It floats in the cement paste or is washed around by it and otherwise behaves largely passively.

The setting and subsequent hardening of the concrete is caused by a chemical reaction that takes place in the cement paste. This process is called hydration. Hydration transforms the liquid cement paste into solid cement stone. This is associated with a certain shrinkage. The aggregates remain

unchanged during this process. Their task is to counteract the shrinkage to such an extent that no shrinkage cracks occur.

Freshly produced concrete always contains a certain amount of air, which is unintentionally introduced during mixing. The expulsion of this air can greatly improve the subsequent concrete strength. This process is called compaction and is usually done with concrete vibrators. They drive the air out of the concrete through vibration and allow it to flow readily into the mould. Of course, this is only possible with concretes that are processed by casting, which is why poured concrete can generally achieve better strength than concrete that is processed by mouldering, laminating or plastering techniques.

With the help of admixtures and additives, which are added to the concrete in small quantities, the processing properties and the subsequent material behaviour can be specifically influenced. These additives can, for example, accelerate the setting, make the concrete sticky, flowable or pasty, or ensure that a particularly high final strength is achieved. They are decisive for the usability of the concrete.

And so not all concrete is the same. Commercial ready-mixes optimised for building purposes are very different from those developed for art and design. Working with the wrong concrete is frustrating, while working with the right mix is really fun. It is worthwhile to always use ready-mixed mortars that are adapted to the respective working technique. A very wide selection of ready-mixes for all applications can be found in the Moertelshop.

The Concrete Workshop

A workplace for creative design with concrete can be set up almost anywhere. The only thing to bear in mind is that dust and mortar stains are unavoidable and that the floor can sometimes get wet. On the other hand, there is hardly any noise, unless you are working on large-scale jobs or those with ultra-high-strength concrete that require a powerful mixer. It is important that the workpiece is protected from direct sunlight, draughts, frost and vibrations during the resting phases. A work table and a water and electricity connection should be available.

Equipment

Working with concrete requires robust work clothing. Steel-toed shoes are recommended when working on large pieces of work, as a falling piece of concrete is a real danger to the feet. Wherever possible, hands should be protected by work gloves to avoid injuries on rough surfaces and sharp edges. It is absolutely essential to wear rubber gloves when modelling with the hands, because the fresh cement mortar is highly alkaline and therefore extremely aggressive to the skin. Other clothing should be comfortable, practical and, if possible, abrasion-resistant.

For most work, a fairly small basic set of tools is sufficient. A bucket for mixing should be available, as well as a second bucket with water for washing the tools. The tools must not be cleaned in the sink under running water, because the cement residues that get into the sewer system can harden and lead to blockages.

Smaller quantities of mortar are mixed with a mortar trowel. It should not be too large, otherwise too much force is needed for stirring. For very small quantities, a plaster cup in combination with a metal spatula has proven successful. The sharp edges of the spatula or mortar trowel are decisive for success, because they introduce the necessary shearing forces into the concrete. If you try using a wooden stick for stirring instead, the difference quickly becomes clear. Unsuitable mixing tools often lead to a complete failure of the entire project, which is why this should be emphasised at this point.

If larger quantities are to be mixed, it is worth using a mixer or at least a strong drill with a whisk. For even larger quantities and especially for high-strength grouts, which must always be mixed with only a little water, a compulsory mixer provides valuable services. The usual concrete mixing drums that are often found on construction sites, are unfortunately

The most important tools for working in build-up technique at a glance: Watering can, plaster cup, construction bucket, rubber gloves, modelling tool, spatula, trowel, spray bottle, vice, bolt cutter, hammer, steel pipe, folding rule, rose shears, work gloves. The vice and the piece of pipe help to bend the rebar. With it, even short ends can still be grabbed and bent at quite a sharp angle..

only of limited use, as the mixing process with them requires too much water in most cases.

It is very useful to have a selection of scraping tools ready, because after setting, the mortar is still soft and can be sculpted without any effort. In addition to spatulas, spoons and dental instruments, a render scratcher that can be used like a sanding block is particularly useful here.

The mixing water should be kept ready in a watering can for small to medium-sized jobs, as it is particularly easy to dose. When modelling with your hands, a plaster cup filled with water or a spray bottle is also indispensable for occasionally moistening the rubber gloves and the workpiece.

For cutting binding wires and light metal reinforcements, a multi-purpose cutter or some garden scissors are well suited. Reinforcing steel is cut with the bolt cutter or with a metal saw or a small angle grinder. The latter two are also suitable for cutting steel cables or rods made of fibreglass and fibrebasalt.

Textile reinforcements such as the common mesh fabrics made of glass fibre, basalt or carbon fibre can be cut well with scissors.

Styrofoam substructures are cut using a sharp knife, a tree saw or a hot wire cutting machine. Individual styrofoam parts can be quickly and easily glued together to form large bodies using construction foam. The purchase of a construction foam gun is highly recommended for this purpose.

The workbench can consist of two simple folding trestles with a board laid on top and can be obtained for little money. You should always try to arrange your working place in such a way that you can work without exertion, because only then you are completely at focussed on your workpiece.

The Material

The choice of the right material is crucial for the enjoyment of the work. It determines whether a workpiece can be made easily and flawlessly and whether it will later have the desired durability. The material should therefore fit the purpose exactly.

Moertelshop (www.moertelshop.eu) offers very good ready-mixed mortars for art and design. The following types of mortar and concrete can be roughly distinguished.

Mortars for art and design are produced according to special recipes and mostly on the basis of white cement. They enable artistic design with concrete in a wide variety of working techniques. A large selection of ready-mixed mortars for all working techniques can be found in the Moertelshop (www.moertelshop.eu).

Base Mortar is used for the build-up technique, i.e. when a workpiece is not cast but built up in layers or stages. It is used to give the workpiece the necessary basic strength and to build up volume. With some restrictions, it can also be used to model surface details.

Large sculptures in particular consist mainly of base mortar, often in combination with glass fibres. For such large sculptures or artificial rock landscapes, it is important that the mortar is machine-compatible, i.e. it must also be possible to process it with a plastering machine. The base mortar differs from the likewise machine-compatible wall plaster mortars in that it has a significantly higher strength.

In the Moertelshop, there are two base mortars to choose from, namely GRUMO, a slow-setting white mortar, and BUMS, an accelerated white mortar. Both can also be mixed with each other as desired to adjust the setting speed to the respective requirements.

Modelling Mortar is similar to basic mortar, but has a very special suppleness. It is used to create surfaces. Because as a surface mortar it runs the greatest risk of drying out too quickly, it contains the finest fibres to prevent cracking. In order to give the modelling mortar a clay-like plastic consistency, it must be mixed with very little water. The best way to do this is to knead in more dry mortar after mixing by hand. If the mass is only a little too wet, it is already too soft to model with. When working with modelling mortar, bales of mortar about the size of a fist are always taken from the bucket and kneaded. Each fresh ball of mortar is then pressed onto the workpiece and spread to the sides with moistened fingers. In order for the mortar to adhere to the substrate, it is essential that it is pre-

coated with a cement slurry, into which the mortar bale is pressed, damp in damp. The cement slurry consists only of cement and water.

The modelling mortar in the Moertelshop is called MOMO. It sets slowly, i.e. it can be worked for about two hours. By adding BUMS it can be accelerated as desired.

Concrete for Kneading is a very fine-grained and high-strength variant of modelling mortar. It is primarily used for modelling smaller and fully solid objects, but can also be used for modelling very fine details on larger objects that were initially produced using the classic build-up technique with base mortar or modelling mortar. It is possible to work without a cement slurry, as the pre-wetting of the substrate is sufficient for a good bond to the substrate when working with concrete for kneading.

It can also be processed using the draping technique. In this case, it is rolled out into thin patties and then nestled like a piece of fabric over a support form or laid in decorative folds (draped) as desired. After solidification, the result is very light and stable thin-walled bowls, lampshades or the like (see page 23).

The Moertelshop sells a choice of white or grey concrete for kneading named PLASTY FIX.

Cement-based Modelling Paste enables the creation of particularly fine details on a concrete object and is also used to subsequently smooth or structure already solidified concrete surfaces. As such fine-grained masses lack the supporting coarser grain size, they are naturally more susceptible to cracking than modelling mortars and are only suitable for modelling smaller areas, for example up to the size of a human nose. After hardening, they are excellent for sanding and allow the creation of very attractive surfaces.

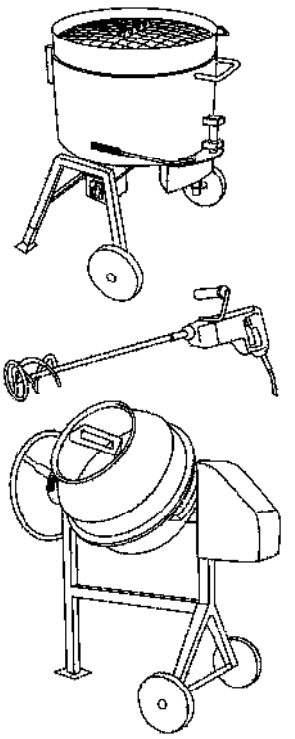
The Moertelshop offers a creamy-white modelling paste called PÜPPI.

Casting Concrete or Grout is intended for pouring into a mould (see page 20) and is already adjusted by the contained superplasticiser in such a way that it flows into the mould on its own, even without a concrete vibrator. It is used for artistic concrete casting, for design and furniture pieces as well as for concrete table tops, because here there is a desire for complete filling of even difficult forms, impeccable casting surface and minimal shrinkage. There are various ready-to-use casting compounds available, which are adapted to the respective requirements for whiteness, hardening speed and final strength. What they all have in common is that they contain very efficient flow agents, which make them compact by themselves during casting. The usual "vibrating into the mould" of the concrete is therefore not necessary and could even be harmful, because it could result in the segregation of the individual components.

Casting concretes of particularly high final strength, also known as ultra-high performance concretes or UHPC, can only be mixed with the aid of mechanical stirring tools, as they require a great deal of stirring energy. It is ideal if a powerful whisk, a stirrer or a compulsory mixer is available. If not, you can also use a standard mixing drum by first mixing only 50% of the dry mass with 100% of the intended amount of water and only then gradually adding the remaining dry mass when a flowable slurry has already formed. Further important information on the properties and processing of high-strength concrete can be found in the FLOWSTONE WORKING GUIDE, which is available as a free download in the Moertelshop.

A large selection of different casting concretes can also be found in the Moertelshop. MOBY DUR furniture concrete is the right choice for applications that require extremely high strength.

If, on the other hand, quick setting and easy processing are the aim, then MOBY FIX should be used for larger objects and VITO PIANO for smaller ones. These mixtures contain CSA cement (calcium sulfoaluminate) as an accelerator, which gives them the additional advantage of setting shrinkage-free or at least shrinkage-neutral. By shrinkage-neutral is meant that the very small volume changes (swelling and shrinkage) that the concrete undergoes during setting amount to approximately zero at the end.



Compulsory mixers (top) and hand mixers (middle) are the right tools for mixing high-strength grouts, because they have to be stirred particularly intensively. Sometimes, however, a drum mixer (bottom) will also do.

GOGOLIT is suitable for cases where low weight is important. PYRAMIT is another lightweight and fire-resistant grouting concrete.

Sculpting Concrete is an exotic among the casting concretes. It is also cast in moulds, but only as a blank that does not yet have the final shape of the intended workpiece. After a short time, the blank solidifies and is then taken out of the mould and carved like a natural stone, i.e. worked using the sculpting technique. The special feature of sculpting concrete is that it initially sets very quickly and then hardens very slowly. This makes it

possible to work on it over several days without effort with light scraper tools. Nevertheless, it reaches a considerable final strength after several weeks.

Sculpting concrete can be used to achieve special colour effects by colouring partial quantities with pigments of different colours in order to cast multi-coloured, marbled blanks. The procedure is similar to that for marble cake.

The sculpting concrete in the Moertelshop is called SKULPTIN.

Adhesive Mortar is the name for a particularly sticky cement mortar that is refined by the addition of a plastic dispersion. This gives it its special adhesive properties even on difficult substrates. Adhesive mortar is needed, for example, to bond mosaics and to lay tiles. As an additive to other mortars whose adhesive properties are not sufficient for a particular purpose, such as the Béton-Mâché technique, it facilitates the work and is sometimes even indispensable. A particularly high-grade variant of adhesive mortar is the so-called flexible adhesive, which has a certain flexibility when solidified and thus helps to relieve damaging tensions. When bonding natural stone, it is important to ensure that the adhesive mortar contains only white cement and no grey cement, so that no undesirable staining occurs.

A very high-quality white and flexible adhesive mortar called KLEMO, which is suitable for all applications, is available in the Moertelshop.

If a plastering machine is available, it can make the concreting of large objects much easier. For this seating platform, red coloured GRUMO was sprayed on in several layers and reinforced with glass fibre fabric laid in layers.

Jointing Mortar / Grout is used to grout tiles and mosaics. A distinction is made between the particularly fine-grained type for very narrow joints and the somewhat coarser-grained type for wide joints. The latter is suitable not only for grouting but also as a thin-layer finishing coat for smoothing rough concrete surfaces, as they are typical for modelled workpieces. The layer should be a maximum of one millimetre thick, which is sufficient to remove the roughness of the substrate. Coarser unevenness and waves cannot be evened out in this way. They must be removed beforehand by grinding the still soft concrete with a plaster scraper.

WARNING

Cement forms a strong alkali in combination with water, which can cause burns to the skin, especially the eyes. If concrete or cement splashes get into the eye, immediately rinse the affected eye intensively with clean water for 10 - 15 minutes. If no running water is available, a container with clean fresh water must be provided in advance for emergencies. Move the eye in all directions during rinsing.

Before coating, the substrate is not pre-painted with cement slurry as is usually the case with the build-up technique. It only needs to be moistened slightly. The grout, which is mixed to a creamy, semi-stiff consistency, is then applied with a wide brush or rubber gloves. In a second working step, the entire surface is rubbed down with rubber gloves about 20 minutes later. The right time for rubbing can be recognised by the fact that the watery sheen on the surface disappears. When rubbing, isolated grains of sand fall out, which act like abrasives and smooth the surface. The result is a velvety appearance reminiscent of sandstone.

In the Moertelshop you will find a white grout and coating mortar called FIFI, which is ideally suited for this technique.

Refractory Concrete is used for objects that are exposed to heat above 570°C, such as fire bowls, Aztec stoves, or artistically designed inner linings for fireplaces. Normal concrete is not suitable for these purposes. It would crack.

Just like normal concrete, refractory concrete is composed of water, cement and sand. However, the cement and sand must meet special requirements. Certain quartz stones must not be included because they show explosive behaviour at higher temperatures. Portland cement, which is otherwise commonly used in concrete, is also unsuitable for refractory concrete and must be replaced by refractory alumina cement.

In principle, the same working techniques (modelling, laminating, casting) can be used with refractory concrete as with normal concrete. Due to the limited selection of raw materials that can be used, however, the achievable processing properties are not quite at the high level of normal concrete.

Refractory concrete reacts more sensitively to processing temperatures that are too low and should not be used at ambient temperatures below 10°C. In addition, covering the fresh workpiece with foil to protect it from drying out in the first few hours is even more important than with normal concrete. If these aspects are not adequately observed, there is a risk of obtaining sandy surfaces.

Another special feature of refractory concrete is that it may only be exposed to high heat after prior kilning (drying). Drying at temperatures of up to 120°C ensures that excess water can slowly evaporate from the interior, which would otherwise develop a high vapour pressure if heated too quickly and break up the concrete

structure. In practice, kiln-drying can be carried out, for example, by heating for a long time in an oven. Workpieces that are too large for this can also be kilned by initially firing them at a very low temperature and only gradually increasing the heat to the desired high temperatures. When firing a fire bowl for the first time, it is best to place the coarse wood at the bottom and the fine wood on top.

For creative applications, the Moertelshop offers the mouldable refractory concrete GRISU and the castable refractory concrete PYRAMIT.

Concrete Floor Coatings, also known as floor levelling compounds, are applied in very thin layers to an existing substrate. They are used to level out unevenness and differences in level and in certain cases can also be used as a wear layer that can be walked on.

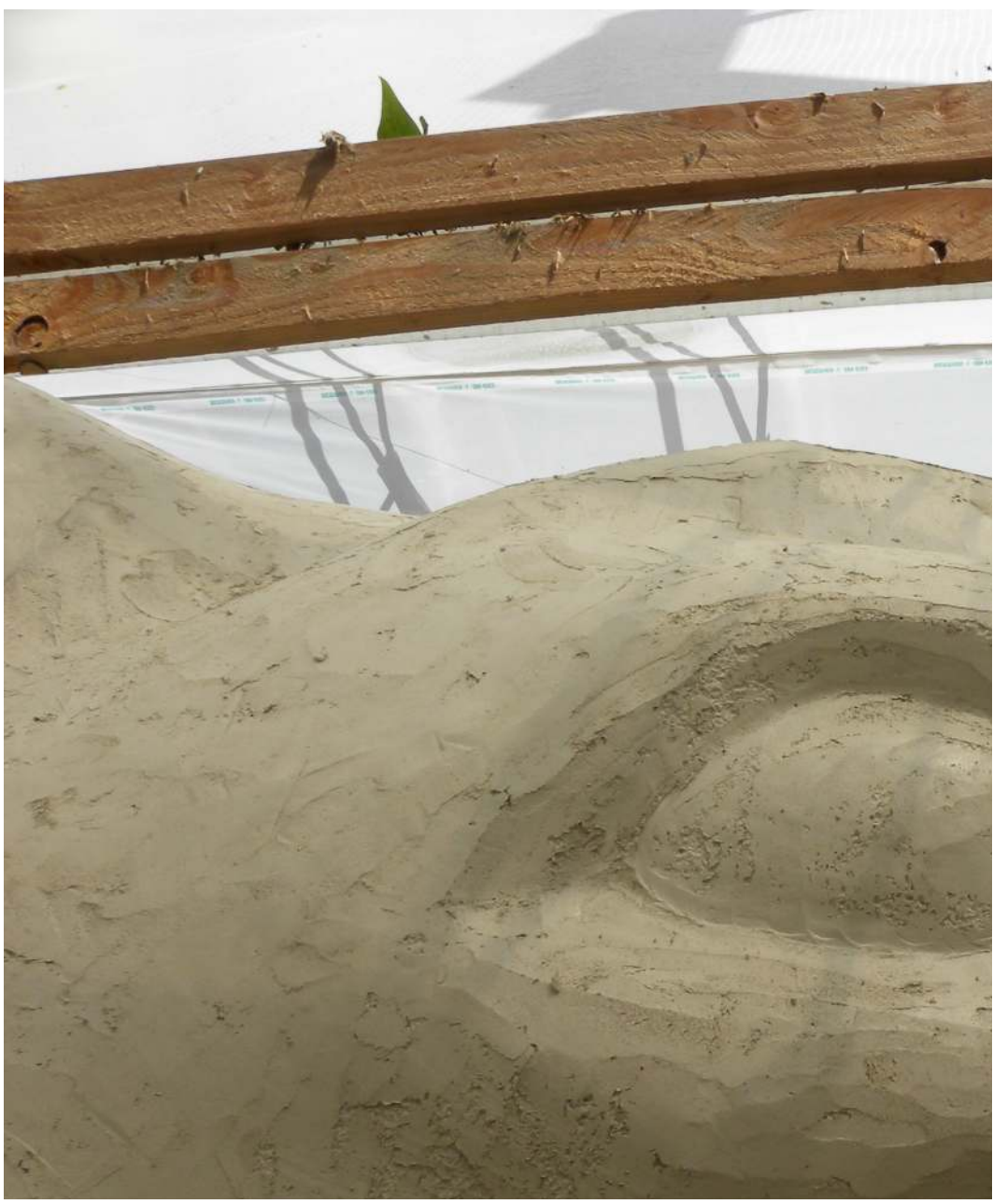
If the use as a wear layer is planned, the substrate should always be primed with a penetrating primer so that no disturbing air bubbles can rise from its pores through the freshly applied compound. It is recommended to spread the mortar on the floor with a rubber squeegee and to massage it into the substrate. This ensures good compaction, which later pays off in higher strength.

For visible surfaces, it is also very important to take shrinkage into account, i.e. the reduction in volume of the concrete after it has been processed. To avoid cracks or detachment from the substrate due to shrinkage, choose a concrete that is shrinkage-neutral or even slightly swellable. In addition, the concrete should have good adhesive properties.

The Moertelshop offers two different concretes that meet these requirements: BASIL and PLAN B. Both set without shrinkage. They differ above all in their final strength. Due to its particularly high strength, PLAN B is not only suitable for highly stressed floors but also for kitchen worktops that are to be produced in situ, i.e. directly on site and without subsequent turning.

Apart from floors, other substrates can of course also be coated with concrete, such as furniture fronts. However, substrates made of wood or similar materials first require a thin layer of adhesive mortar as a load-bearing layer, which is able to adhere well to the substrate and, due to its roughness, provide sufficient support for the subsequent top layer of BASIL or PLAN B. A light mesh is usually also worked into the adhesive mortar.

Concrete Wall Fillers are often referred to as micro-cements. Unlike classic plaster mortars, they are very fine-grained and are applied in very thin layers. The surfaces created in this way can be given a very individual appearance by smoothing with a trowel, by sanding or by other means. The numerous micro-cements offered on the market require a very different degree of skill and technical ability from the user. MARFINO CONCRETE SURFACE, available from Moertelshop, is one of the few micro-



cements that can be processed particularly easily and accurately.

Since these mortars have a very fine grain size, i.e. the coarser, so-called support grain is missing, they are more susceptible to cracking than normal concrete. For this reason, they should only be applied in thin layers. To prevent the thin layers from drying out too quickly, it is also particularly important to pre-treat the substrate with a penetrating primer.

If the surface to be trowelled is very smooth and there is doubt that the compound will adhere well enough to it, KLEMO Adhesive Mortar can be used as a contact bridge to create a grippy surface for the subsequent layer (see also section Adhesion to the Substrate, page 24). This also makes it possible to trowel directly onto tiles.

Cement-bound Wall Paints are, technically speaking, concretes with very fine aggregates, similar to microcements. They can be applied with a brush or paint roller and are therefore hardly distinguishable from the usual synthetic resin-bonded dispersion paints. However, unlike these, they are not flammable after setting and are completely insensitive to moisture, which is why they are particularly suitable for damp cellar rooms, steam saunas and the like. The appearance of cement-based paints is dull matt like that of natural stone.

The Moertelshop sells a white, cement-bound wall paint under the name MARFINO PAINT, which can be coloured as desired by adding pigments.

Laminating Concrete is a concrete that is processed in thin layers and reinforced with textile reinforcement layer by layer. In this way, a mould can be lined with a thin layer of concrete instead of being completely filled. After hardening, the result is a hollow workpiece instead of a solid one. This creates thin-walled and therefore light, shell-shaped objects. The Moertelshop offers LAMBO laminating concrete, which is very similar to kneadable concrete, but is not kneadable but spreadable.

Sprayable Concrete can be laminated using the spraying technique, which offers the advantage of a very efficient working method and is therefore particularly interesting for building large objects such as the whale house on page 4 and for series production. A plastering machine or a workshop compressor with a hopper spray gun can be used as spraying equipment. It is important that the material is so stable that it does not slip or flow away even on vertical surfaces. The GRUMO base mortar mentioned above is very suitable for plastering machines. For applying thin coatings with a hopper spray gun, use a finer-grained mortar such as BASIL or LAMBO instead. The mortar consistency must then be adjusted in such a way that the mass still flows well in the hopper of the spray gun, but remains stable when sprayed onto the wall and has a sufficient layer thickness (see

page 22). If necessary, use a suitable additive for this purpose.

Wood-Chip Concrete is a rather exotic type of concrete in which the aggregate is replaced by wood chips. The material therefore essentially consists of cement, water and wood chips. Its composition makes wood-chip concrete pleasantly light compared to normal concrete, but it has only limited resistance to weathering. Typical objects made of wood-chip concrete are birdhouses and hedgehog boxes. Of course, much more can be created with it.

In addition to wood chips and portland cement, the usual wood-chip concrete recipes also include an accelerator, which has the task of cancelling out the strongly retarding effect of the wood chips on the setting process. The special cement WUTZ offered in the Moertelshop for wood-chip concrete is already equipped with the necessary accelerator and also contains other additives that make it possible not only to tamp the material into prepared moulds, as was customary in the past, but also to model freely with it.

Due to the wood contained in wood-chip concrete, the curing after the actual concreting must be carried out differently than with normal concrete (see section Curing, page 26). Exceptionally, it is not important to keep the concrete moist for a long time by covering it with foil, but to ventilate it well all around so that the excess water can evaporate evenly on all sides. If this is not ensured, excessive swelling of the wood chips can occur here and there, which subsequently leads to cracks in the workpiece.

Lightweight Concrete is obtained by replacing the usual sand or gravel with lightweight aggregates. The market offers a wide variety of lightweight aggregates, such as pumice gravel, perlite, expanded glass granulate, expanded clay or polystyrene crumbs. This makes it possible to reduce the concrete weight to a third or less. However, the achievable strength of the concrete is drastically reduced with the weight. In addition, lightweight aggregates make the concrete very porous, which can greatly limit its weatherability.

Foamed Concrete is a particularly light form of lightweight concrete in which the granulation is replaced by air. In this way, the concrete weight can be reduced to less than a fifth. However, the concrete then only has a low strength and tends to shrink more than normal concrete. Foamed concrete is primarily used for special tasks in construction, e.g. for filling cavities or as a heat-insulating layer. It has hardly arrived at all in the field of creative design work with concrete, despite its excellent properties. The main reason for this is that the production of foamed concrete first requires a foaming device that is capable of producing a stable foam from water and foaming agent. This foam is then mixed into the concrete to finally obtain the foamed concrete. Until recently, the foam units available on the market were designed exclusively for the production of large quantities and were correspondingly expensive and large. In the meantime, however, Moertelshop also offers small and handy devices such as the PUNKY foam whisk, the SPUMATOR SIMPLEX and the SPUMAX foam case, which make it possible to produce small to medium quantities of foam quickly and cost-effectively.

Although it is extremely porous, foamed concrete can also be made waterproof by adding hydrophobic agent. The right cup was sealed with PREN.

Reinforcement

Concrete can withstand a lot of pressure, but not as much tension. In other words: A piece of concrete is very difficult to crush but relatively easy to tear. This is not a problem with compact workpieces that are exposed to low loads. However, if the shape of the workpiece gives the impression that something could break through or break off under load, reinforcement is required.

To reinforce the concrete, rods, meshes or fibres are embedded during processing, which can be made of steel, glass, basalt or carbon. This helps it to withstand high tensile loads without damage.

The steel mesh structures that can be used include large-format welded structural steel mesh as well as finer variants such as screed mesh made of thin wire, ribbed expanded metal, which was very common in the past as a plaster base, or galvanised rabbit wire.

Compared to bars made of fibreglass or fibre basalt, the metallic reinforcements have the advantage that they can be bent and thus better adapted to

the requirements of complex geometries. Their heavy weight, however, makes them less suitable for floating installation, for example in thin table tops, because they sink to the bottom in flowable concrete. For this purpose, fibreglass or fibrebasalt rods are more suitable. They have about the same specific density as concrete and remain in the position where they were placed during the casting process. Their slight tendency to rise can be suppressed by mixing a small amount of short fibres into the concrete or by placing a fibre fleece (mat) on the bars.

In addition to the glass fibre mat already mentioned, textile mesh reinforcements are also common in flat objects such as table tops, which can be made of glass, Basalt or carbon fibre. They have a much higher load-bearing capacity than short fibres or glass fibre mats.

When selecting glass reinforcement for concrete, it is particularly important to ensure that the glass is alkali-resistant (so-called AR glass) as otherwise the material may decompose over time.

It depends on the respective task how and with which material the reinforcement is best to be carried out.

For the build-up technique described in more detail below, the use of steel bars, ribbed expanded metal, rabbit wire and AR glass fibre mat proved to be very useful. Examples of objects created in this way are the whale house on page 4, the seatpost on page 8 and the dragon's head on pages 10 and 11. In the case of the whale house, a steel cable was used as reinforcement in some places. It is obvious that a steel cable can also be used as reinforcement considering that the reinforcement only has the task of absorbing tensile forces.

Lattice textiles made of AR glass, basalt and especially carbon fibres are ideally suited as reinforcement for flat slabs such as kitchen worktops. You can find out more about this in the TEXTILE CONCRETE WORK GUIDE, which is also available as a free download in the Moertelshop.

Galvanised metal reinforcement: rebar, steel cable, rabbit wire

Reinforcement made of alkali-resistant glass: AR mat, AR short fibres, AR fabric

Corrosion

If a steel reinforcement is deeply embedded in the concrete, it is protected against rust. So after installation, a rusty reinforcing bar will not continue to rust in the concrete. This is due to the alkalinity of the concrete. If, however, the steel is not deep enough, i.e. less than 2 to 3 cm below the concrete surface, this protective mechanism no longer works reliably and one must expect rust damage that is very difficult to repair and gradually drives the concrete apart (see picture below). It is therefore advisable to use galvanised steel as a precaution for particularly slender design elements or to consider reinforcement made of glass fibres, carbon fibres or basalt fibres.

But here too, as already mentioned above, caution is advised when choosing the material. In contrast to steel, glass is not protected by the alkalinity of concrete, but attacked. That is why only alkali-resistant, so-called AR glass fibres may be used in concrete.

Basalt fibres are also not completely resistant to alkalis. Therfore, they are treated with special impregnations for concrete applications, which make them resistant to the alkaline environment of the concrete. With basalt fibres, somewhat higher strengths can be achieved than with glass fibres. The combination of basalt fibres with refractory concrete is particularly favourable, as the basalt fibres are very heat-resistant and the refractory concrete is only slightly alkaline. Here, even non-impregnated basalt fibres can be used.

Carbon fibres are completely resistant to corrosion and alkalinity.

Efflorescence

Efflorescence is a white haze that is deposited on the surface of the concrete and is usually perceived as disturbing. It consists of tiny calcite crystals. The crystals only form when the circumstances are favourable, which is not always the case. They are particularly noticeable on dark concrete surfaces.

For efflorescence to occur, there must be enough so-called free lime in the concrete. This is an unused component of the cement that remains after setting. It is dissolved by water and flushed to the surface. The free lime is eliminated by offering it a reaction partner that can bind it in the concrete. This increases the strength, thus

In this wall, the concrete cover is too small. This has allowed the steel reinforcement to rust and the top layer to blast off.

bringing a double benefit. The required reaction partner is a so-called pozzolan, such as trass, metakaolin, microsilica or coal fly ash.

In addition to the free lime, water is also necessary for efflorescence to occur. This is why it is found particularly often in gardens and outdoor areas where the concrete is exposed to free weathering and rising moisture from the soil. However, they also tend to occur in very young concrete that still contains a lot of unused water from its production. Therefore, water should be used sparingly when mixing the concrete. Reducing the amount of water is also advantageous for the strength, and therefore one should always try to use only as much water as absolutely necessary.

Most ready-mixes from the Moertel shop contain pozzolane and are therefore already quite insensitive to efflorescence. Especially in the case of mixtures for casting, it is very helpful to keep the period in which efflorescence can form short. This means that the concrete should set as quickly as possible and the casting should then be removed from the mould as early as possible. An accelerated setting concrete mix such as TURBO 20, MOBY FIX or VITO is more favourable in this respect than an unaccelerated concrete such as MOBY DUR. But it is even more important not to pour at too low temperatures, because heat is a very effective accelerator, and if it is missing, everything goes very slowly. This is also the reason why you always get better concrete surfaces in summer than in winter.

This retaining wall is permanently exposed to soil moisture. Leaking water has led to white efflorescence here.

Building a concrete sculpture

A concrete sculpture is created by applying mortar to an existing base body. This procedure is called the build-up technique, in contrast to the casting technique, in which the concrete is poured into a prepared mould. The base body is usually a metal framework that later assumes the function of reinforcement. During construction, it must be able to bear the weight of the concrete even without the supporting help of the concrete.

As an alternative to building on a metal framework, it is also possible to build on a temporary base body that is removed after completion or at least does not retain any load-bearing function. For example, a gymnastics ball can be used as a base body for the production of a concrete sphere. For this kind of application, glass fibre mat is used instead of metal reinforcement (see YouTube video WERKANLEITUNG BETONKUGEL for details https://youtu.be/E4phjBoXNWM)

Metal should always be avoided for refractory objects, as softening and thus failure of the metal reinforcement occurs at higher temperatures. Glass fibres are also not an ideal material here. Basalt fibres, on the other hand, may be used in fire-resistant concrete because of their relatively high melting point.

If you decide to use metal reinforcement, then the construction begins with the production of a stable wire body, possibly stuffed with filling material, which already has approximately the final shape of the sculpture. In the further course of the work, it is covered with a concrete shell about 3 cm thick, which means that the wire body must be about 3 cm smaller all around than the contour of the sculpture. For figures with slender body parts such as the neck, wrists or ankles, special care must be taken so that the wire body does not become too thick there.

All points that could later break off under load are strengthened by means of steel bars or steel cables. These must be arranged in such a way that they are completely embedded in the concrete, because this is the only way they can develop their load-bearing effect. Binding wire or cable ties are used to connect the metal parts to each other. Intentionally protruding metal parts must either be rust-proof or provided with corrosion protection if the sculpture is to be installed outdoors.

Once the basic wire structure is stable and steady, it is fixed in place with the help of the first layer of base mortar. This gives it the rigidity that will keep it in shape during the next steps. In the case of very large metal frameworks, it can be helpful not only to tie the assembly bars together with wire, but

To build up smaller figures on rabbit wire, it is best to use an accelerated modelling mortar, e.g. a mixture of MOMO and BUMS in a ratio of 1:1. Compared to working with clay, this offers the advantage that the setting takes place very quickly and virtually without shrinkage. As a rule, you first apply plenty of material and a short time later, when the mortar has set, you scrape away all the excess. This process is repeated until the desired shape is achieved.

also to weld them together at their contact points in order to provide more rigidity even before the mortar is applied. In general, however, it is also possible without the use of a welding machine.

If a plinth plate is planned as a base, it should be made while the workpiece is still light and easy to handle. If possible, base plates are made using the casting technique, because this is the best way to achieve strength. In order to make the plate and the workpiece inseparable, they must be joined together by means of several steel bars.

Ribbed expanded metal has only limited formability and is therefore more suitable for large objects. For smaller objects it is better to start the construction by making a suitable polystyrene body, which is then lined with rabbit wire. For even smaller objects, just use rabbit wire. Crumple it up like a piece of paper and form the desired body from the ball as if it were modelling clay.

If you choose polystyrene, you will find 50 cm x 100 cm sheets in the shops. They are available in thicknesses of up to 10 cm. With the help of building foam, you can glue together structures of any size. Until the foam has hardened, the individual parts are held in place with adhesive tape or pins. If a foam gun is available, the foam can be dispensed very cleanly. The smallest quantities can then be taken out and the bottle resealed so tightly that the unused residue remains fresh for a long time.

For large objects, some effort is first required to build the substructure. In this picture, it consists of ribbed expanded metal, which is strengthened with mounting irons laid on top. The fixing layer, which is being applied here, still shows metal parts in places, which will later disappear under further concrete layers. The GRUMO base mortar is suitable for this work.

Fibre Concrete

Supporting bodies made of polystyrene are particularly suitable for working with glass-fibre reinforced concrete. They can be used to create thin-walled, shell-shaped objects such as spheres, seat stones, vases and other vessels very easily. The alternating application of individual thin layers of concrete and glass fibres is called laminating. The first layer for such workpieces is a continuous layer of GRUMO basic mortar, about 1 cm thick, to which the longest possible alkali-resistant glass fibres are mixed. Ideally suited for this technique are the approx. 5 cm long fibres of the AR glass fibre mat, as shown on page 13. The fibres of the mat are not woven together but held together by a water-soluble adhesive. On contact with water, the mat disintegrates into individual fibres, which can then be easily mixed into the mortar paste.

The hardened first coat is followed by at least one more coat to increase the strength and to close any gaps. In any case, between two coats, the substrate must always first be levelled and roughened with the help of the plaster scraper. Then remove all crumbs from the surface and pre-wet it with cement slurry, which is a simple sauce of water and cement. Now the second coat can

The construction of larger objects begins with the production of suitable tubes from ribbed expanded metal. The picture shows the individual tubes for legs, arms, torso and head. The stuffed tubes (e.g. with bubble wrap) are tied together with binding wire or cable ties to form the desired body. Depending on the expected load, the whole thing is then strengthened with mounting irons. The result is a rigid substructure that is capable of supporting the first concrete layer, i.e. the fixing layer, without deforming noticeably under its load. The dimensioning of the expanded metal tubes for a life-size person, for example, can be made easier by measuring the length of the limbs on one's own body and transferring it to the tubes with some allowance for the joints.

The fixing layer is followed by the volume layer and the covering layer. As the name suggests, the volume layer serves to build up volume where it is needed. This process can of course be divided into several stages or individual layers. The final top layer is used to create the surface, i.e. details such as facial features, eyes, nose, ears, superficial wrinkles, etc. The mortar is used to fix the surface in place.

The mortar for the fixing layer is mixed much softer, i.e. with more water, than for the volume layer, because when fixing it is important that it can penetrate as well as possible into the meshes of the wire framework. It is completely different with the volume layer. Here, a mortar that is as stiff as possible (with little water) is needed so that the applied material does not melt away. A mortar that is too soft inevitably (and with beginners almost regularly) leads to unnecessary frustration.

be applied in the same way as the first coat. Alternatively, starting with the second layer, it is also possible to lay the glass fibre mat flat in the cement slurry and work it in with the help of a wide brush and further cement slurry so that no more white fibres show through. On top of this, a layer of base mortar is applied wet-on-wet and spread to form a layer about 1 cm thick. With this variant, no fibres need to be mixed into the mortar, which saves work and also has the advantage that no tufts of fibres can protrude from the surface after re-smoothing with the plaster scraper.

The technique is described in detail in the YouTube video WERKANLEITUNG BETONKUGEL which can easily be found via the corresponding link in the Moertelshop or directly at (https://youtu.be/E4phjBoXNWM).
The supporting base body used there is a gymnastics ball.

Proceed in the same way with refractory modelling mortars, but use refractory cement for the cement slurry and replace the glass fibres with heat-resistant basalt fibres.

Ultralight Concrete

The ultralight concrete technique is a special variant of the build-up or lamination technique described above, which can be used to produce extremely light concrete objects that are nevertheless fully suitable for outdoor use. The supporting body is usually made of polystyrene. However, an existing object made of papier-mâché can just as easily be used as a supporting body, which can be made weatherproof in a very simple way with the help of a thin coating of concrete. Sturdy corrugated cardboard is also a suitable base. For example, it is no problem to quickly and easily make a few weatherproof yet light concrete blocks out of cardboard boxes as decorative objects for the garden.

Instead of base mortar, pure cement is used, thus saving the weight of the granules. In addition, the layers are made extremely thin so that only very little material is needed. However, this only works if enough glass fibres are mixed into the mass of water and cement to prevent cracks. Because there is also an increased risk of the cement drying out too quickly and causing damage when it is applied in such a thin layer, an adequate cement mix must be used. WUTZ, a special cement that is also used for wood-chip concrete (see page 12), is very suitable for this purpose.

The required mixture consists of 500 g WUTZ, 300 g water and 25 g glass fibres. Everything must be mixed intensively and beaten to a creamy pulp with a trowel or by hand (wear rubber gloves!). It is advisable to mix only small portions of approx. 1 kg at a time, because larger quantities are more difficult to mix and because the mass solidifies very quickly.

The material is spread onto the substrate with a narrow trowel to a thickness of approx. 1 to 2 mm. After setting, a second layer is applied in the same way and finally, for smoothing, a third layer with a slightly different composition. Here, instead of the glass fibre mat, the dispersible AR glass short fibres of type D12 are used to make the surface as smooth as possible. The above-mentioned ratio of WUTZ/water/fibres, however, remains unchanged.

With the ultralight concrete technique, precoating with the cement slurry otherwise obligatory for the lamination is not necessary, because WUTZ is already tacky enough by itself.

It is worth waiting until the mass has set before smoothing the surface or shaping details. Material that has not yet been processed, which has remained in the mixing vessel and has only just solidified there, can still be used if it is kneaded until it is soft again. It is perfect for modelling small details. The slightly stiffened mass is also suitable for making the workpiece more solid in places that are particularly sensitive to impact and for embedding a wire or two there for reinforcement, if required.

The workpiece can be reworked as often as desired with the same mixture. However, a combination with other types of mortar is not recommended.

Béton-Mâché

The mâché technique offers a supplement to the techniques described above. With this technique, it is possible to produce large-volume bodies quickly and easily without using any filling material at all. The prerequisite is that the shape of the workpiece is suitable for this technique, i.e. that it has a large standing surface and tapers towards the top. It must be comparable to a sugar loaf in the broadest sense. As with the papier-mâché, the substructure consists of rabbit wire. The base is additionally reinforced by a ring of iron. This is first bent to shape in a vice and then attached to the lower edge of the wire body. The concreting process now begins by embed-

In the ultralight concrete technique, the special cement WUTZ is mixed with two types of AR glass fibres (picture above left): fine short fibres for the top layer (left in picture) and coarse glass fibre mat for the substrate (right in picture). The substrate mortar is applied only 1-2 mm thick per layer (picture above right). The fine top coat mortar (picture below left) is finally applied even thinner to smooth out only the unevenness (picture below right).

ding the lower edge of the wire body, which has been iron-reinforced, in a bead of base mortar. This gives the whole thing the necessary stability for the following work steps. Once this is ensured, the rabbit wire is progressively covered with a very thin layer of mortar from bottom to top. For this to work, the mortar must have certain properties that go beyond those of ordinary base mortar. A mixture of two parts of BUMS, one part of KLEMO and a quantity of mâché fibres, to be dosed according to one's own feeling, has proved successful. The mâché fibres are made of polypropylene and are not to be understood as reinforcement. Their function is to ensure that the mortar does not fall through the meshes of the rabbit wire. After a few days, the mâché mortar is so hard that the very light object is stable and weatherproof.

Regardless of whether the workpiece was created using the mâché technique, the laminating technique or the classic build-up technique, it can be supplemented and enhanced at any time, i.e. even months later, by applying further layers of mortar. To build up additional volume, a base mortar is sufficient. If, on the other hand, details are to be modelled, it is better to use a modelling mortar or a concrete for kneading. Here it is even more important than with the base mortar that the mixture is not mixed too wet. This is the only way to obtain a mass that can be modelled well and has similar working properties to clay. It has proved useful to mix the mortar with a little water first and then to knead in the dry mixture by hand until the consistency is right.

The drier the mortar is applied, the more important it is to pre-wet the substrate with water or cement slurry to ensure a good bond. You should make it a habit to always have a plaster cup full of cement slurry and a second cup of water ready at the workplace. The water is mainly used to occasionally moisten the rubber gloves very slightly. This creates a sliding film between the gloves and the mortar, which makes spreading much easier.

Casting Technique

For reproductions and whenever a particularly high final strength or a flawless surface is required, it is best to use the casting technique. Of course, this requires mould making, which in itself is a demanding discipline and will not be discussed further here. However, excellent mould materials and instructions for mould making can easily be found on the internet.

To get a good concrete cast from a well-built mould, you need the right concrete mix. Self-compacting concrete is best suited for art and design objects because it does not require a vibrator for compaction. A ready-to-use, self-compacting casting concrete has approximately the flow properties of honey. The optimum amount of water to be added is usually stated on the bag label and must be adhered to very precisely. If too little water is added, mixing becomes very difficult and the self-venting, i.e. the rising of stirred-in air bubbles, does not function properly. If, on the other hand, the mortar is over-watered, the coarser mortar particles will settle at the bottom and the finer ones on top, which is called demixing. Puddles of water then appear on the surface.

Segregation can also be a result of unnecessary vibration. Unlike the concretes commonly used in construction, a self-compacting grout should not be vibrated if possible. It compacts all by itself due to the superplasticiser it contains.

A self-compacting concrete runs into the mould like honey. If you pour it in a thin stream, you can avoid unwanted air pockets. It must not be vibrated, because the retained superplasticiser could cause it to segregate.

The greater the water requirement of the casting concrete, the easier it is to mix and the lower its final strength. For casting decorative figures that are not particularly filigree and for which strength is hardly important, you will choose a rather simple casting concrete such as STEINGUSS that requires a lot of water but is easy to work with. For a thin-walled table, on the other hand, which is intended to be as robust as possible as an object of daily use, a high-strength concrete such as MOBY DUR should be used instead. It needs much less water, but requires much more powerful mixing tools.

Silicone Moulds

Silicone is a flexible, rubber-like moulding compound that is ideally suited for the production of small concrete moulds. It is very easy to process, non-toxic and produces long-lasting moulds that do not require any release agents during use.

Unlike the one-component construction market silicone used as a joint compound in bathrooms, casting silicone consists of two components. As soon as both components are mixed together, the so-called cross-linking begins, which results in the hardened silicone after the respective setting time. The period of time during which the silicone can be processed is referred to as the pot life.

Moulding silicone can be used to make moulds for any object. Because it is as elastic as rubber during demoulding, undercuts are no problem. It is also very easy and safe to work with. However, for a silicone mould to work well and last a long time, some experience in mould making is needed. You can find practical instructions for making this coffee cup mould in the Moertelshop under the menu item YOUTUBE or directly at the Internet address https://youtu.be/ZTsP5yzq5fM.

There are silicones with different pot lives and different degrees of hardness. On the hardness scale introduced by Shore and named after him, typical values for silicone are between 10 and 90. The softer a silicone is, the more suitable it is for castings with particularly pronounced undercuts. The harder types, on the other hand, have the advantage that they wear less quickly. A Shore A hardness of 20 is the right choice in most cases.

It goes without saying that when choosing the silicone, one should pay attention to the highest possible tensile strength and elongation at break, so that the mould will last for a long time. The viscosity also plays an important role. The higher the viscosity, the more viscous the liquid silicone behaves during processing, and this can be a hindrance to its deaeration. Mixing inevitably introduces a considerable amount of air into the silicone, and this must be completely removed if you want to make perfect concrete casts with the mould later. So you should prefer a silicone with the lowest possible viscosity. By the way, professional mould makers use a vacuum pump to deaerate the silicone.

An important feature of addition-curing silicone (A-silicone) is that it can be incompatible with certain materials, such as compounds or putties containing sulphur. In contact with these materials, cross-linking is prevented, which results in the silicone remaining liquid and sticky on the contact surface and thus the silicone mould is lost and the model is soiled. To avoid this problem, it is always advisable to carry out a compatibility test in advance or to use a condensation-curing silicone (K-silicone).

Spraying Technique

As already mentioned, concrete can also be processed using the spraying technique, whereby there are several variants to distinguish between.

Industrial applications, such as those used for tunnel construction, generally work with very complex technical equipment, methods and materials that cannot be easily transferred to

The funnel spray gun is very useful for applying the mortar easily and quickly to larger areas. The additives contained give the mass exactly the required consistency and stability. Smoothing is done with the smoothing trowel.

the smaller scales of the artistically oriented concrete designer.

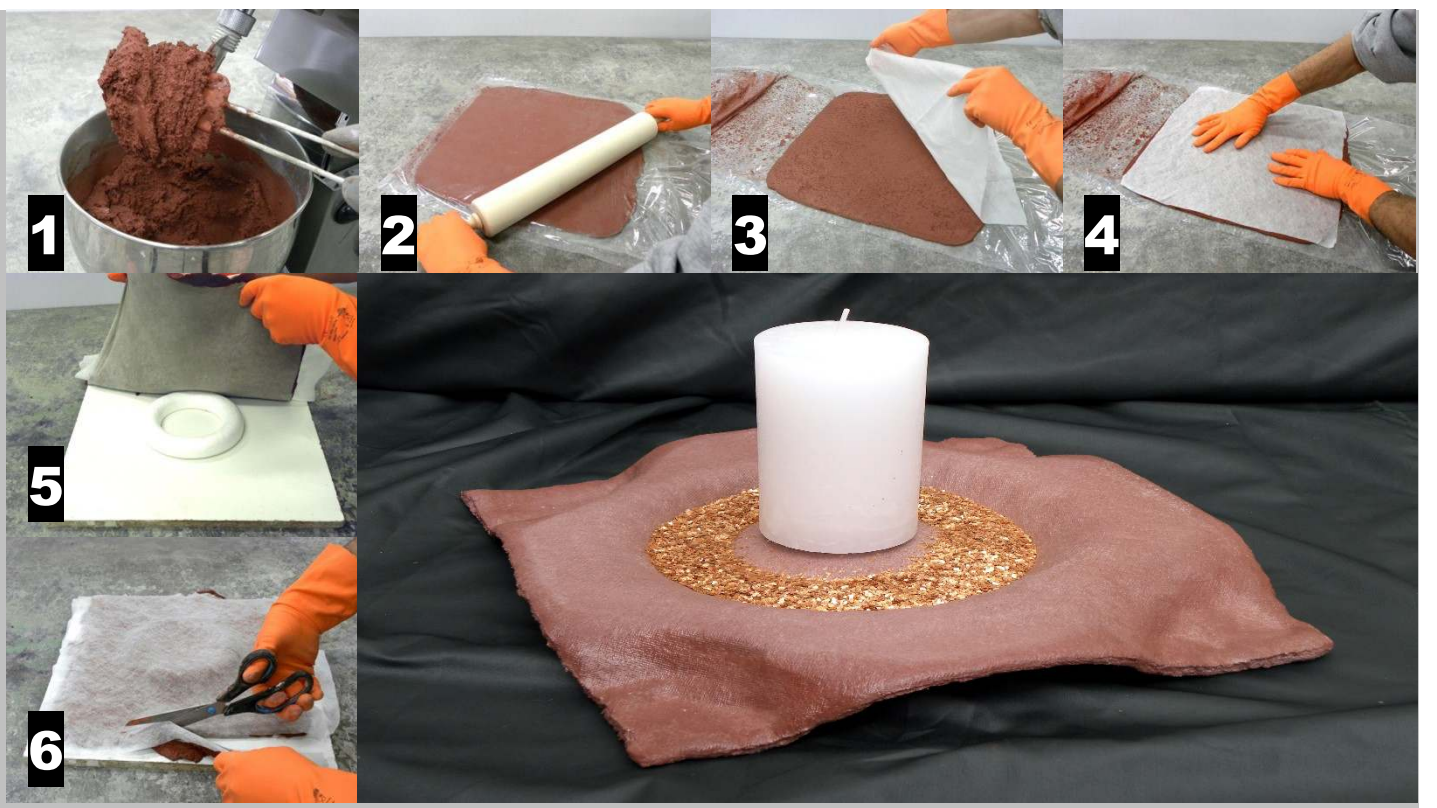
In contrast, the plastering machines commonly used in house construction can also be used on a smaller scale and are recommended for concrete objects weighing 1000 kg or more. The appropriate concrete is GRUMO (see illustration on page 8). However, extensive instruction is required for the operation of such a machine, which is why one should not get involved without thorough preparation.

A third and much simpler technique is to use a funnel spray gun, which requires only a powerful workshop compressor in addition to the gun itself. The gun has a funnel-shaped container on its upper side into which a mortar quantity of about 5 litres fits. Gravity causes the mortar to flow from the funnel down into the gun and from there it is sprayed onto the wall or into the formwork with the help of compressed air. However, this very simple principle only works well if the consistency of the mortar is adjusted appropriately. On the one hand, it must be fluid enough to flow continuously from the funnel into the gun, and on the other hand, it should no longer flow once it has been sprayed onto the wall. The LAMBO laminating concrete available in the Moertelshop has the corresponding properties. However, other concretes can also be made sprayable by adding WISKO admixture and/or FLUP superplasticizer, whereby the appropriate proportions must be determined in a preliminary test.

Draping Technique

With the draping technique you can easily make very thin-walled and therefore light objects whose appearance is reminiscent of textiles. Ideal pieces are lampshades, vessels and table decorations. However, the technique can also be applied to larger objects such as designer furniture.

To achieve the best possible strength, it is best to use concrete for kneading. The kneadable mass is rolled out with a rolling pin between two sheets of plastic film to form a pancake a few millimetres thick. In the simplest case, the pancake can be left as it is, i.e. with the plastic film on it. It is then draped



The draping technique is a special way of working kneadable concrete. To do this, the concrete is rolled out between two plastic sheets with a rolling pin to form a thin pancake (picture 2). Then the foil is pulled off on the top side and later also on the bottom side and replaced by draping fleece (picture 3), which is massaged into the surface with the hands (picture 4). The patty, reinforced on both sides with fleece, is draped over a prepared support (picture 5) and neatly trimmed at the edge with scissors (picture 6). The most suitable draping material is embroidery stabilizer, which is made of polyvinyl alcohol (PVA). It is water-soluble and can therefore be washed off with water and a brush when the concrete has hardened.

over any supporting body and laid in decorative folds. Only when the concrete has set do you remove the foil again. This very simple procedure results in a concrete surface with numerous air pockets due to the plastic film.

Alternatively, if the air pockets are undesirable, a bubble-free surface with a textile structure can be achieved by removing the plastic films one by one from the freshly rolled out patty and replacing them with drape fleece. The drape fleece not only gives a different surface structure, but also behaves much more elastically during draping than a plastic film. Therefore, it is much easier for the pancake to fit curved supporting bodies without wrinkling. Another advantage is that the edge of the patty can then be easily trimmed with scissors. The fleece is water-soluble and can easily be washed away later.

As reinforcement for the draped object, AR glass fibre mat can either be mixed in during concrete preparation or AR glass fibre fabric can be rolled into the underside of the concrete slab later. Often, however, the reinforcement can be dispensed with altogether, especially when draping small objects.

Textiles soaked in cement paste are another material suitable for draping. They allow a very simple and intuitive way of working and, if they are built up in several layers, offer astonishing strength despite their very low weight. The right choice of textile fabric used as a base is particularly important. It must not be too dense so that it can absorb as much cement paste as possible. Light cotton gauze, which is also used for muslin bandages, is very suitable. For making the cement paste, the flow cement CEM-FLUP is recommended, available in the Moertelshop, because of its extremely high strength.

Setting Time

Concrete usually takes a day to set. It has then by no means reached its final strength, but it is already somewhat resilient. For creative work with concrete, this means that a casting can be removed from the mould after about one day. A modelled piece can be further modelled after a waiting period of one day. You should wait at least 2 weeks before placing the workpiece outdoors.

If you want to work faster, you can use accelerated mortar mixtures. In addition to the usual Portland cement, these also contain another type of cement that produces the accelerating effect and is therefore also called accelerator. In the past, this second type of cement was usually refractory alumina cement. More recently, CSA cement has been increasingly used,

If you soak thin cotton gauze in a cement paste consisting of water and the flow cement CEM-FLUP, you can use it to cover any object, such as these plastic plant pots. The result is a very light, hard and weather-resistant outer shell of concrete, which can be smoothed and structured as desired by applying further thin layers of concrete.

which can be produced in a much more environmentally friendly way and also has some other advantages, such as a particularly high early strength.

Depending on which accelerator is contained in the concrete and how high it is dosed, the processing time is reduced from normally 2 hours to a period of between a few minutes and an hour.

The accelerated concrete can achieve a very high strength in a short time. This can be used, for example, to quickly provide a sculpture in progress with a stable base plate and then, after a short interruption, immediately return to modelling. However, when using accelerated mixes, it is important to bear in mind that although the very young concrete can already bear loads, it must not yet be exposed to direct sunlight or draughts. Concrete, accelerated or unaccelerated, can only tolerate this after it is a few days old (see section Curing, page 26). Even with accelerated concrete, it is better to wait 2 weeks before putting it into operation.

Adhesion to the Substrate

It has already been explained above how, in the build-up technique, cement slurry is used to ensure that concrete layers applied one after the other bond with each other. Cement slurry is a mixture of water and cement that is made about as fluid as wall paint. Use it to prime the substrate and then apply the new mortar layer wet on wet. Sometimes it is sufficient just to prime the substrate with water. However, if this is forgotten, poor adhesion and the risk of later detachment are almost certain. Therefore, the following rule applies: Never pour concrete onto a dry substrate!

If the mortar used contains a relatively large amount of water, it may be possible to work without the cement slurry. However, the slurry is indispensable when working with modelling mortar, because modelling mortar is mixed with very little water.

The mechanism of bonding with the substrate can be described as follows. The cement slurry (= cement paste) runs into all the cracks in the substrate and solidifies there to form cement stone. The more fissured the subsoil is, the better the cement paste can anchor itself in it. Consequently, a rough substrate is more favourable than a smooth one. A substrate that is too dry or too absorbent is unfavourable, because it withdraws the water from the cement slurry even before it has run into all the cracks. That is why it is so important to moisten the substrate before starting work.

If the substrate is too smooth, the described mechanism of anchoring does not work. This can be helped by adding a polymer dispersion to the cement slurry, as it is also contained in adhesive mortars. A polymer dispersion in powder form called ACRO is available in the Moertelshop.

Shrinkage cracks are caused by stresses from the setting process. In the case shown here, the fault was that the hard surface layer was applied to a substrate that was too soft. Instead of absorbing the stresses from the setting surface layer, the soft substrate gave way. As a result, the surface layer cracked and came off.

Shrinkage

When working with concrete, it is important to know that it shrinks slightly during the setting process. The shrinkage, i.e. the amount by which the volume decreases during the setting process, depends primarily on the composition of the concrete.

When casting a workpiece, the shrinkage is typically less than one mm per m edge length. Consequently, the effects of shrinkage are not normally noticed. However, if a larger rigid body is poured in, such as a wooden placeholder for the hob recess in a kitchen worktop, then even this small amount of shrinkage will cause very large stresses in the concrete that will cause it to crack. It is therefore essential to ensure that everything that is cast into the concrete as a displacer is as soft and pliable as possible. Styrofoam has proven to be a possible material for this purpose; wood or metal, on the other hand, are unsuitable.

If a workpiece is produced using the build-up technique and fresh layers are applied to underlying layers that have already completely or partially set, shrinkage leads to a high risk of cracking. The substrate, which no longer shrinks because shrinkage has already taken place, prevents the fresh layer from contracting during the setting process. As a result, each new layer stretches tightly over the previous layer, and it can happen that where the tension becomes too great, visible cracks appear in the surface.

Cracking is favoured by the following circumstances:

- The fresh layer covers a very large area in one piece.
- The fresh layer is too thick.
- The substrate is too soft (e.g. light mortar mixtures).
- The substrate adhesion is not sufficient.

- The mortar is not ideally combined or contains too much water.

In practice, you protect yourself from such damage by holding back on adding water as much as possible, ensuring good adhesion to the substrate, using proven mortar formulations and incorporating glass fibres when designing large surfaces.

Waterproofing

There is often a desire for a completely waterproof concrete, for example for flower vases or other vessels made of concrete. As a rule, concrete is already waterproof by itself, unless it is a particularly low-quality or light and porous mixture. In the case of vessels with thin walls, however, it sometimes makes sense to add a sealant. This is called mass hydrophobic treatment, because the agent is mixed into the concrete mass and not used as a surface treatment. In addition to silanes, the technical soaps zinc stearate and sodium oleate are proven active ingredients for this purpose. A sodium oleate with the trade name PREN is available in the Moertelshop. When applying in grouting concretes, it should be noted that the flowability may be somewhat reduced by the hydrophobic agent. This can easily be counteracted by adding a little superplasticizer.

Curing

Especially in the first days after setting, it is important to protect the concrete surface from water loss. Hydration, i.e. the transformation of water and cement into stone, is then still in full swing and constantly consumes water. If not enough water is available, the concrete will be damaged and cracks will form.

In practice, it has proven useful to wrap the fresh workpiece in foil to protect it from drying out due to sun and draughts.

When the concrete has reached a certain hardness, it becomes less sensitive. Then the foil can be removed and the excess water, which is not needed for hydration, gradually dries out.

It is important to know that the hardening of the concrete is a result of hydration and not of drying. That is why we do not say "the concrete dries", but "the concrete sets".

This explains why concrete cannot be kept fresh in airtight containers like a wall paint. Once cement and water have come together, it depends only on the temperature how quickly or slowly the reaction proceeds. The colder it is, the longer it takes.

Surfaces

Concrete surfaces can be designed and preserved in many ways. It is important for all measures that the surface must not be sealed airtight if it is intended to be installed outdoors. The concrete must always be able to release gaseous water from its interior through evaporation. For this reason, only so-called diffusion-open final treatments can be considered. The concrete designer has a wide range of acrylic and mineral paints as well as dirt- and water-repellent glazes, impregnations, stains and waxes at his disposal. The Moertelshop offers a variety of possibilities. Here you will also find a comparative table sorted according to active ingredients.

Contact with Food

Concrete is not toxic, and contact between concrete and food is therefore not associated with any health hazards. For example, wine barrels are also made of concrete. But of course, depending on the concrete recipe, small amounts of additives may be contained for which such general harmlessness does not apply or only to a limited extent. There is generally no reason to worry, if only because of the very small dosing quantities anyway, but if you want to be absolutely sure, you should ask for a certificate of analysis that officially certifies the harmlessness. Of course, this applies equally to the concrete mix used and to the surface treatment agents.

Disposal

Concrete waste produced during work is part of the construction waste. Dirty water from cleaning the tools is collected in a large container and left to stand until a layer of sediment has settled on the bottom. The clear water above can then be poured into the sewage system and the sediment sludge added to the construction waste. If this separation is not carried out and everything is poured into the sewage system instead, there is a risk that the cement will set there and cause a stubborn blockage.

Have a look at the Moertelshop!

PIGMENTS

READY-MIXED MORTAR

REINFORCEMENT

PAINTS

TOOLS

In the Moertelshop you will find everything for designing with concrete. We have artists' mortar for every working technique, tools, paints, pigments, reinforcement and much more. Just take a look. Our shop is open for you around the clock.

www.moertelshop.eu

ISBN 978-3-943039-05-4