

**CONTENS IN GENERAL
LAMINATING TESTING DIRECTIONS
FOR FRP COMPONENTS
OUT OF GLAS SILK FIBRES
MATS AND WOVENS
WITH REACTION RESIN MASS INCLUDING
THERMAL PLASTIC LINING MATERIALS**

1. IN GENERAL

Introduction to material knowledge of plastics

Plastics have penetrated without interruption into our daily life the last years. They get more and more acknowledged as of full value next to metal and wood.

Their simple fabrication and processing open always new application ranges but which should be chosen fitting to the plastic.

The question 'What are plastics?' isn't easy to answer.

Mid lat century materials were already known which had very good skills like untearability, tenacity, elasticity and abrasion resistance, but less were known about their structural arrangement. The starting material have been macromolecular links, which are still used today, namely cellulose, proteins and unvulcanized rubber. Since the basic works of Mr. Staubinger it is known that macromolecules are built of several hundred atoms. Plastic - plaster or polymer named as well - consists of macromolecules.

Plastics are materials which are made of natural materials (unvulcanized rubber, cellulose etc.) or synthetical produced of organic links (ethylene, benzene, formaldehyde)

The physical behavior is dependent on
the size of the middle molecular mass
the net of the chains and the crystallization tendency
the kind of the transmolecular linking power and
the intensity of linkage.

Due to the very scientifically behavior the plastics are arranged in three big groups:

Thermal plastics or plastomer

Duroplastic or named duromer and

Elastomer or briefly elaste.

Plastics find a huge application area nowadays, resulting in the range of variety of their skills.

In all areas of everyday living you can find plastics, because they have advantages in special application areas against conventional materials.

These advantages can be explained with an easy forming, at present low price, with specifically skills like good insulating properties or corrosion endurance or the weight of the formed parts as well.

Despite these advantages it should be cared for the use that plastics are organic materials and that they grow old.

The designer should pay attention for planning of a form part on:

Is the form part well constructed to the plastic ?

May differences in the contents of the starting material result in a sooner symptom of fatigue ?

Which testing methods may be used ?

Which load will the form part, deal with at which temperatures and environmental conditions ?

Will it be processed by qualified staff ?

A lot of flaws and danger sources can be avoided by critical examination of these aspects and sufficient special knowledge.

The worker / supplier has to take care as well, that at wrong proceeding already a dismantling of the moleculars happens, conditioned by wrong handling of the materials and the compliance with the given parameters.

Just for the use of plastics in the engineering area a lot of knowledge of the skills and quality consciousness is required by the worker.

To face the always increasing requirements of quality, the technical user departments of the raw material supplier and some testing institutions are at the workers disposal.

In-service quality control and checking by official institutions at the same time, warrant a high quality standard which is getting more important to the name of the worker.

This enhanced consciousness is important for the future of the plastics, because in the past, the plastic has got a negative image by wrong choice.

The increasing usage in the car-, aero- or chemical industry requires more and more reinforced and high temperature resistant materials.

Duroplaste will become more important, because they show a higher / longer long term temperature resistance and moreover, own emergency running properties.

Plastics can have different upgradings.

Upgrading means the steps of processing which are necessary to produce a plastic mould mass out of the raw material.

The steps are breaking (granulating, milling)

mixing in solid status

and mixing in plastic status.

Basically every plastic is able to be reinforced by a fibre formed material.

Customary is the reinforcement of reaction resins with fibres.

That are in general:

POLYESTER RESINS

EPOXY RESINS

VINYLESTER RESINS

Also some thermal plastics would be reinforced with fibres and reacting resins, because of their specifications and physical characteristics. Belonging to these are the following:

POLYETHYLENE

(Abb. PE, coloured black) this is collectively a good substance, high tenacity and ability to stretch without splitting also has good electric insulating properties.

POLYPROPYLEN

(Abb. PP and can be identified with the colour grey or beige) processes also the typical properties, for example low density, likewise high stiffness, hardness and firmness, a high temperature durability until + 110 °C, electric insulating properties like PE, a resistance against weak organic acids and alkalis, alcohol just like oils and detergent agents.

POLYVINYLCHLORIDE

(Abb. PVC and depending on the situation and which and what additives are present, then it is recognized with the colours red or grey) processes in general high chemical properties-, specialised in shielding against nitrates in a solid form or dissolved in a liquid - mechanical firmness and stiffness just like in certain compositions even with self dissolving properties after the flame is removed. Last but not least:

POLYVINYLIDENFLUORIDE

(better known under the abb. PVDF and of milky colour normally white) This material has extraordinary good chemical and physical properties to these are also accounted very hard and tough durability which during processing makes it very ambitious. Even so it has a very high firmness and stiffness, so this corresponds to a high abrasion resistance which entails for a long lasting duration of the constructed parts especially supporting parts.

Once formed, moulded the material has a large flexible temperature range which can be used from - 60°C to + 150°C and linked with the resistance to chloride and bromide makes it a very much important piece of thermal plastic material. All this produces a weather proof product which coupled with the self dissolving effect rounds up its qualities of course there is a price to pay.

Reinforcing is created through fibres containing composite materials have opposed to the unreinforced materials giving substantially more elastic components (That means higher stiffness and obviously more load) distinguished between the two. Reinforcing is carried out using glass fibre, most are endless type, used in the melting spun process produced. This technique is also used in the textile industry and usually work the same, here it is called textile glass fibres.

To improve the adherence between the glass fibres and reaction resins, they have to be supplied with an adhesive medium. Glass fibres will be delivered in different shapes to the worker. Beside the endless fibre there are also glass pile fibres with certain fibre length. From that glass mats or glass battings are produced for example. The glass fibre give the components made of FRP the essential part of their solidity. Depending on the used product the mechanical values are accentuated in one direction ('UD = Uni Directional glass fibre or named weaving thread) or in two directions (better known as fabric) . Glass mats have equal values in each direction, but on an essential lower level. Mould part made of

GLASS (G) FIBRE STRENGTHENED (F) PLASTICS (P)

and pipeline parts may differ from their completed construction due to their application area. The GIS 16965 and GIS 16966 show several possibilities. So the components according to pipe type B are characterized with an inside coating of thermoplastic plastics or elastomere and a specific laminate construction. For customary thermo plastic the above mentioned are required, but also other coating materials.

On the other hand is the pipe type D, consisting of a strong chemical resisting inside tack of 2,5 mm minimum, the so-called chemical surface protection (CSP) and a given laminate construction with specified glass part. Still left to mention is pipe type E, the last one in the standard pipeline classification, which is very resin rich in the production and as a result doesn't resist to the thin walled pressure load. This type is set in extreme aggressive chemical medias, even in the medium itself. The pipeline components can be manufactured of the usual trading measures of DN 25 to DN 100 and by calculative solidity proofs moreover. The usual pressure steps are here as well

PN 2,5 / PN 4 / PN 6 / PN 10 and PN 16.

The Usability of a component is determined by skills of both glass and artificial resin on the one hand and the quantity proportion on the other hand and not least by choice of the manufacturing procedure. The choice of the manufacturing procedure is determined by following aspects:

- the size and quantity of the components
- the required constant measurement and quality of the surface
- and the kind of strengthening material and the resin.

This checking instruction describes all instructions for the production and quality saving of FRP - Components. It is applicable to carrying and not carrying FRP - building parts with and without inside coating.

2. TREMS AND THEIR MEANING

FRP	: abbreviation for fibre reinforced plastic
GFP	: abbreviation for major term glass fibrereinforced plastics
UP-Resins	: abbreviation for all polyester resins
V-Resins	: abbreviation for all Vinylester resins
EP-Resins	: abbreviation for all Epoxy resins

Hardening:

Transportation of liquid resins to solid state means addition of hardening agents and accelerators.

After Hardening:

For causing a final status normally only by means of warmth hardening or warmth after - hardening (Temperung) to obtain optimal skills.

Separating agent:

Separating agents are special waxes or plastic dissolving foils, which avoid the touch of resin with the tools. At the same time the separating agent has no affinity to the resin.

Fine layer:

An outside cover on the component consisting of pure resin. Thereby the surface of the component will be improved essentially.

Glass silk texture:

Glass silk texture is a fabric manufactured of glass fibre thread, whereby the order of warp threads and weft threads matching each other and the thread thickness are decisive for the kind of fabric.

Laminating:

The working process laminating means that several layers of glass texture will be piled up and each layer after laying down will be soaked with a reactionable resin.

Reaction resin mass:

Ready - to - work mixture consisting of EP-, V- or UP- resins, hardening agents and possibly accelerators.

Technical delivery conditions:

Containing all requirements towards glass textures and resins.

Pot time:

The pot time is the time, within the finished resin mixture is ready to work with regard to workability and warranty of the material skills after hardening. It is visibly determined by the increase of the viscosity of the resin during advanced hardening. The pot time is finished for UP - resins by first indication of beginning of gelatinization of the still to work resin.

The pot time is finished for EP - resins with a sensible increase of the viscosity of the resin, due to always gradually increasing, so here must be worked particular carefully. The pot time is always determined by kind and quantity of the hardening agent, temperature and the volume of the disposition.

3. QUALIFICATION

3.1 QUALIFICATION OF LAMINATING AND PROCEDURE

The staff is supposed to be familiar to procedure by sufficient training, that means by qualification and pointment to production institution and the material specific basic working conditions. The exact contents of the laminating instruction must be known to the staff at least.

For the qualification of the manufacturing procedure, respectively of the laminating, the representative respectively the production technical / critical components of a group are to be layed down and manufactured by an independent testing company respectively ist co-workers according to the specification and / or testing regulations Laminater of DVS 2220-board.

The qualification of the procedure and the laminater could take place together. The working process and / or testing process has to be recorded, rated and documented.

A certificate has to be issued by the testing company about the grade of accomplishment and its date of expiration.

3.2 VALIDITY OF THE QUALIFICATIONS

The qualification of the laminator will be valid for 2 years after first successful taking off (acceptance), if it is checked in periodical intervals.

Otherwise the handed over qualification certificate is just one year valid.

Repeated examinations have to be passed in an interval of two years.

The qualification of the production procedure is valid for 5 years minimum after first successfully taking off. In case of no procedure amendment the qualification is unlimited.

Every procedure amendment is connected with a new qualification is examination.

Repeated examinations may passed within the scope of production control.

The proceedings are fixed.

4. IMPORTANT MARGINAL CONDITIONS

For the phases of operation, rooms are necessary which are supplied with an adjustment for temperature from 5°C to 30°C, relative humidity of 85% max and dust-free.

In cases of less than 35% rel. humidity only products may be worked on which encroachment of quality by humidity, is excluded (supplier remark).

Otherwise test plates are produced in presence of quality supervision.

The connecting area must be free of humidity.

In open air a portable protection roof over the link is recommended.

Producing laminates of temperatures <+5°C some additional phases of operation are required to produce equal valued laminates as of temperatures >+5°C.

- 1) The resin working on must be warmed up to >+5°C to keep the necessary viscosity.
- 2) The component should be warmed up with a heating lining or heating a spotlight before the start of laminating. The temperature on the component shouldn't exceed +25°C before laminating start to avoid a too quick reaction of the resin.
- 3) After finishing the laminating work warmth must be supplied again; either means heating spotlight or heating ribbons, which may be fixed inside or outside. The supplied energy accelerates the selfreaction of the resin. The resulting exothermic reaction hardens the laminate correspondingly.

- 4) During tacking works on the mounting spot, small quantities of resin may be warmed up with heating spot, bowl-fire or heating lining. After creating the tacking seam, it must be supported with warm supply as well.

For weighing the resin and hardening agent or accelerator there must be scales and / or a measuring cylinder with according precision to be able to pass the next phase of operation.

For huge quantities (barrel goods) for mixing the resins with the hardening agents and accelerator a stirring apparatus (500 to 1000 qm) is required.

5. WAREHOUSING

References for stocking hardening agents and accelerators are contained in the instructional pamphlet of the professional association of the chemical industry: „Organic Peroxide“.

Due to danger of fire and explosion catalysers mustn't ever be stocked next to accelerators. For stocking resins and glass fibre dry and temperature controlled rooms must be available, for not reducing the stock durability and rendering the material unusable.

Resin or reinforcement, which are contaminated with water mustn't be used.

Attention: Resins, paste, adhesive, catalyser or cleaning materials (acetone) never store in areas with open fire, hot surfaces or blazing sun.

Cool or in separate rooms stored containers must be left closed in the workshop and opened just when they have arrived the same temperature as the room before starting production. If the expiration of the material in room temperature is very short, there must be a different way to avoid precipitation while opening the containers e.g. through quick warming up of the closed containers to room temperature or a bit above.

The containers used for storage must be marked clearly.

Contents and possible instructions e.g. date of expiration must be definitely written on the marking.

The glass fibres must be handled that way to keep their usability as reinforcement material.

During every movement, particularly while cutting and moving the cut pieces, one has to take care of not amending the structure of the fibre.

The textures mustn't be marked with applied means, like crayons or s. th. Else, neither on the cutting edges.

After taking off the package the textures must be stored carefully to avoid every pollution like dust, liquids etc.

Every touch with separating liquid should be avoided.

In any case glassfabrics aren't allowed to lay on preparations with applied separating liquid, e. g. for fitting the cut piece.

Soiled glass textures mustn't be used for the production anymore.

6. ACCEPTANCE OF GOODS

For freight acceptance should be paid attention to:

- completeness according to delivery note
- delay of consignment
- movement of transport fixings
- damaged cartons or boxes
- damaged cargo

Arising problems report to forwarder and company direction immediately.

7. DISCHAGEMENT AND APPROPRIATELY HANDLING

All products handle with care to void damage.

Pipes or assembled pipes, which won't be shipped in boxes, should be discharged in following way only:

- by hand (just small, light sizes)

loops or ropes, which will be raised with raising machine or a fork - lift truck (all sizes),

- fork - lift truck (only for 300 mm radiator or smaller, unplied)

Pipes, links or assembled pipes, which will be shipped in boxes, should be discharged in following way only:

- by hand (only small boxes)
- loops or ropes with a raising machine

- fork - lift truck.

The fork of the fork - lift truck never put into the pipes to lift.
Products, chemicals or cutting tools do not throw from the lorry or let them fall down.
Pipes never leave on stones or rough ground.

The pipes are fragile, so handle with care

DO NOT USE CHAINS OR WIRE ROPE.

For avolding damage do not load unequal or one-sided.

If necessary, cover shipment fixing or wood saddle with carpet material for symmetrical load distribution during transport of huge pipes or assembled pipes. During transport of unwrapped products the forks of fork - lift trucks should be covered with wood or carpet material.
For fixing of the consignment use metall- or nylon -belts and during lorry - transport supply these belts with carpet material, wood or wood fibres plates.

Do not use chain fixing lever

Pipes and assembled pipes never pile uncarefully.
Pipes stock on even surface or and. Avoid a jagged load. Products mustn't touch stones etc.
Don't store in snow, because during melting of the snow unequal lod may happen.
For avoidance of unequal load cover fixungs possibly with carpet material of fibre plates or use saddles.
Pipes, links and assembled pipes are layed with ultra - violet filters and may stored in the sun. Unprotected links have to be covered, if the storage space is exposed to dust, fat, tar or soot, therefore the surface binding may be influenced.

**COMPLICATED COMPONENTS OR STRUCTURES WITH CRITICAL
ARRANGEMENT SHOULD BE STORED AS FAR AS POSIBLE FLAT ON THE
MOUNTING FOUNDATION: PROTECT FROM BLAZING SUN TO AVOID
DISTORTION.**

Remark: Distorts are normally just of short duration, but couldn't be guaranteed every time.

8. UNPACKING

Check, if all pieces noticed on the bill of lading, delivery note or on the list are available or listed as subsequent delivery.

Ascertain before storage, whether all single pieces, assembled pipes or mounted pipes etc. are marked or for later easily found, marked according to technical customer marking.

Take care of unpacking the peces to avoid damage, like deep scratches or crashes. Particularly the conical pipe ends must be examined for flaws or brocken parts. Unassembled protective coverings should be renewed or substituted by accordingly materials.

9. CHOICE OF RESINS

For laminating works only the resin noticed in the drawing or in the component instruction may be used. If different resins are used for the same component (e. g. fine stack or laminate), or mixed together, the compability must be assured. For the hardening of the resins only hardening agents and accelerators may be used remarked in the drawing or in the component instruction.

If there is no instruction for using a hardening agent for the resin, the worker may chose from the company and type dependent restriction of permitted hardening agents.

For EP - resins a particular hardening agent is respectivly admissible.

If several hardening agents are used in the same disposition of resin (e. g. hardening agent and accelerator) they will be adjusted regarding their mode of action.

NEVER MIX ACCELERATOR; LIKE DMA OR COBALTNAPHTHENAT DIRECTLY
IN MEKP

AS A RESULT OF IT FIRE OR EXPLOSION MAY HAPPEN

(FIRST MIX WITH RESIN)

10. PROCESSING AND PREPARATION

The mixing proportions given by the supplier have to comply with the instructed exactness.

The supplied hardening agent to the resin has to comply with an exactness of + / - 1 %, if the supplier didn't instruct something else.

The supplied quantity of hardening agent and accelerator to the UP - resins mustn't amount to less than 1 % and not more than 4 % of the disposition of the resin, if nothing else is said.

Hardening agent and accelerator should used in same proportions.

For warmth hardening of UP - resins the accelerator is inapplicable in general.

The above mentioned extreme points are allowed only for the hardening agent.

Deposit just as much resin as it is possible for the time allowed for processing.

The pot time is, as far as adjustable, to chose in such a manner that the extention of the deposition is to handle. For mixing of more than 2 components to a disposition the sequence is resulting of the instruction of the supplier or general experience and should mixed one by one.

The more exact the mixture ratio is cared after, the more is to be cared for the mixing of the whole disposition equally. The mixing tools must work not only in the middle of the cup, but also to the wall and bottom of the cup. Repeated wiping off the cupwall is recommended.

Only unwaxed cups are allowed to be used, which couldn't give elements to the resin mixture. The mixing tool must be cleaned or thrown away after usage immediately, so that attached resin rests couldn't get into other mixtures. Precise cleanness is required for all handling, therefore no pollution of any kind may get into the resin. Resin depositions, which contens isn't known or couldn't be corrected must be annihilated.

For fine layer resins the above mentioned instructions are valid as far as transferable.

For the fine layer only, for the reason marked and only the required resins are allowed to use.

If a colour hue for the fine layer is instructed in the drawing so fine layer resins will be preferred which will be delivered by the supplier with the requested colouring already. Substitutional suited fine layer resins can be dyed under consideration of the colouring matter should be chosen corresponding to the achievment of the required effect, not higher. Strong delaying or accelerating colouring matters will be able to invalidate the mentioned extreme points under circumstances, if a special hardening agent addition is not compelling instructed.

The fine layer resin is sprayable with a certain spraygun or with other possible tools, like wool roller, brush or something similar, applicable by hand.

The thickness of the fine layer should be steady if possible.

Missing spots, bubbles, drops should be avoided.

Recommended tools for laminating are scrapers with rounded corners for even flat areas, wool rollers for one side bented areas and brushes for spherical areas. The brushes should not be too soft and don't loose bristles.

Do not use more resin than it is necessary to soak the texture without bubbles. The achieved wall thickness resulting from the quantity of the used resin must be between the extreme points.

Every kind of deviation in the structure of the texture is to avoid, if possible.

Creases, overlapping and cuts, due to the spherical form of the component and insufficient ability to pull down the texture which should be avoided, are to be carried out the following rules:

Creases are not allowed.

Overlapping of the cut materials shall be at least 10 mm wider to prevent inclusion of the seam strands. Cuts are expected; where the texture has not been cut into, than creases would be seen, only where creases are expected. Cutting the texture piece by piece, this is senn with a 20 mm wide overlapping and nothing more.

Where there are strands present, the overlapping must be 10 mm. When this is not possible the texture must be placed together and pushed together. This joint is then covered with a 30 mm wide stripe of layering of the same material, to cover the cutting joint this is overlapped.

Overlapping and cuts must, as much as possible, be placed in different places in each layer.

If in the drawing the warp thread in each layer is set out then this must be followed to the letter. For reinforced warp thread is exactly the same, no deviations allowed.

Local reinforcements have to be laminated in continuously texture layers if they are to be used and may only appear on the surface layers i. e. the last layer. These exceptions and requirements must be written down.

For the laminating work tools must not come contact with seperating agents except those tools which have had the seperating agents removed.

Tools such as brushes and rollers should only be used with types of resin. Tools should be regularly cleaned, skaken and dried, so they can be used again. Cleaning agents left, can ruin the hardening effect in the resin.

The chosen reaction resin mass must be hardened in the known temperature extreme points regarding to the material data sheet or material power sheet.

The working time or pot time of the resin can differ from the temperatur. The warmer, the shorter the pot time. You need 15 to 30 minutes at 24°C and 30 to 60 minutes at 18°C.

The resin mustn't be used if it has started to gelatinize.

Important:

THE HARDENED LAMINATE IS SUPPOSED TO HARDEN JUST AS THE PIPE

The resin must be hard. With most of the resins a Barcol minimum tester is to be used with a scale divided into 30 divisions. The Barcol - hardness would be measured with a barcol testing machine. Check whether or not the tester is calibrated correctly.

When a Barcol hardness Tester is not available than a knife point can be used if the hardened resin is as hard as the pipe itself.

Pipes and pre-wrapped components with complete conical ends can be delivered ex work.

When such pieces are to be delivered pipes and fittings are sealed that means emery, sanding or cleaning onsite if necessary. The components lengths should be leaned from GIS 16965 and GIS 16966.

The pipe part is to cut with quick bandsaw or circular saw, diving plate or handsaw accordingly to the sizes and required breach mentioned in the drawing.

The cutting edges are to be sanded and grained with fine sandpaper grade 400.

The pipe end angles must be within the tolerance given according to GIS 16966.

In the area a filler with resin and a hardening agent should be used and not anything else unless otherwise told so. The paste must not be allowed inside the gap and inside the pipe.

That hinders the flow.

At 21°C the paste hardens after 10 - 20 minutes. By colder conditions a heating lamp should be used to achieve an orderly bond. Hardened paste should be as hard as the surrounding pipe. If this is not the case, i. e. soft and rubbery, then more time will be allowed when this does not help the work must be repeated.

WARNING:

The heating lamp can cause blistering or smoke, when it is placed too close or too long on the paste. It is to take note, the material is inflammable.

11. LAMINATING THE JOINTS

The corresponding sheet of paper for the laminating order would be found and either compared to the producer's recommendation or the GIS 16966.

From this standard, the appropriate number of layers, the type of reinforcement and the length and width of the reinforcement shall be used.

The strengthening stripes shall be laid out in order on the working table.

The appropriate resin measured. A box or strong paper shall be placed close to the working place. In the container the joints should be soaked with mixed hardener and resin until the fibres are full, the excess removed with a wool roller. The reinforcement carefully lifted out and the jointed area wrapped up. The glass fibre texture should not be stretched. Afterwards the air bubbles should be pushed from the laminate with a brush; using a pushing movement with the end of the brush. No brushing movement should be made.

Between each layer lots of air must be removed.

A laminating or painting roller helps a lot.

The first two layers must be separately covered. The rest of the reinforcement can be placed over in groups of 2 or 3 layers. In doing this you must be careful that the overlapping appears in different places resulting that the jointing is mixed.

The glass fibre material should not give.

12. PERSONAL PROTECTION

Personal protection equipment is helmet, working gloves, safety shoes, dust masks, splash back glasses and eventually working overalls shall be provided from the employer fitters. It shall be noted the above protection shall be a regularly looked after and you remain responsible.

Because of technical process reasons the following protective and assistance for the hands are needed:

- fluffless cotton or leather gloves
- rubber gloves
- protective hand cream.

With contact with resin and all other appropriate catalysers like acetone must be used in well ventilated rooms.

Never in light spaces, closed rooms without collegial system and without supervision from a qualified supervisor or foreman.

When the air supply is not sufficient breathing apparatus must be used (Warning: only with doctors permission examination (G 26)).

In case of fire: For fire fighting CO² powder or foam can be used. Water to cool the resin and the catalyser when stored within the area of the fire. Large fires should be dealt with hoses.

When resins have over reacted they can produce large amounts of heat which can cause burning.

SMOKING OR BLISTERING MATERIALS SHOULD BE IMMEDIATELY CARRIED OUTSIDE AND PLACED IN A CONTAINER FULL OF WATER

All materials coming in contact with water or fire fighting chemicals should be collected and placed for environmental refuse.

Empty canisters / barrels in which are stored resin, acetone or other chemicals should never be welded on or cut with a torch.

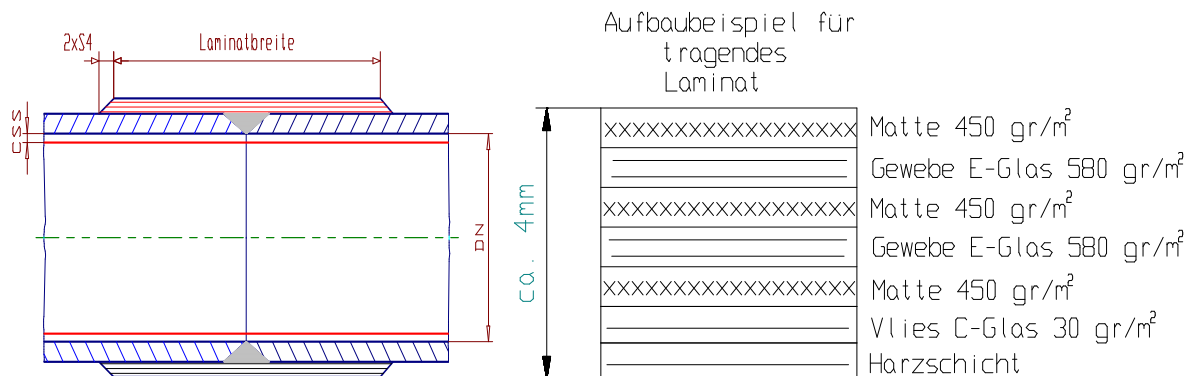
Definitely no smoking, welding, sparking or naked flames allowed where adhesives, pastes, resins, acetates or catalysers are used or stored.

- Explosion protected electric motors or compressed air motors must be used in areas where mixing of concentrated resins-, activators-, catalysers- or acetone- steam are found.

Examples for a work standard

Laminated measuring were carried out for the special pipe Type K.
The wall thickness of the laminate each individual pipe would be calculated with the following formula:

Laminate thickness ($s_4 - CSS$) x 1,5



Laminatethickness in mm					
DN	2,5 bar	4 bar	6 bar	10 bar	16 bar
25	3,8	3,8	3,8	3,8	3,8
32	3,8	3,8	3,8	3,8	3,8
40	3,8	3,8	3,8	3,8	3,8
50	3,8	3,8	3,8	3,8	3,8
65	3,8	3,8	3,8	3,8	3,8
80	3,8	3,8	3,8	3,8	3,9
100	3,8	3,8	3,8	3,8	4,8
125	3,8	3,8	3,8	3,8	5,9
150	3,8	3,8	3,8	4,4	7,0
200	3,8	3,8	3,8	5,7	9,3
250	3,8	3,8	4,2	7,0	11,6
300	3,8	3,8	5,0	8,4	13,8
350	3,8	3,9	5,9	9,8	16,1
400	3,8	4,4	6,6	11,3	18,3
450	3,8	5,0	7,5	12,6	20,6
500	3,8	5,6	8,3	14,0	22,8
600	4,0	6,6	9,9	16,7	27,3
712	4,8	7,7	11,6	19,4	31,7
800	5,4	8,7	13,2	22,2	36,2
900	6,2	9,8	14,7	25,0	40,7
1000	6,8	10,8	16,4	27,6	45,2

DN	Laminatewidth in mm
25	130
32	130
40	130
50	130
65	130
80	130
100	130
125	160
150	160
200	185
250	260
300	260
350	300
400	350
450	400
500	400
600	500
712	500
800	500
900	500
1000	500