

# **Processing Instructions for GRP piping systems for bonding and lamination**

## Processing Instructions

### Content

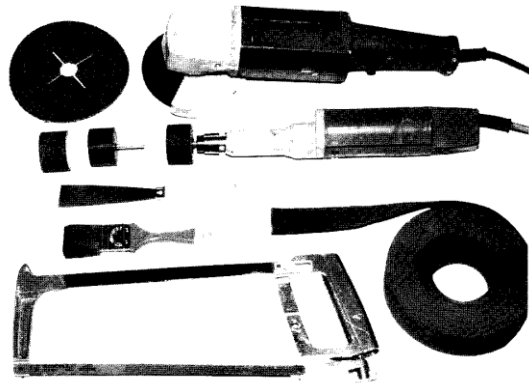
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## 1. Bonding technique

### 1.1. Working procedure

#### Preparation

Thorough preparation before starting bonding operations will ensure that the work can proceed smoothly. Make sure that all required pipes and fittings, together with a sufficient quantity of adhesive, are at hand before starting work.



#### Cutting pipes

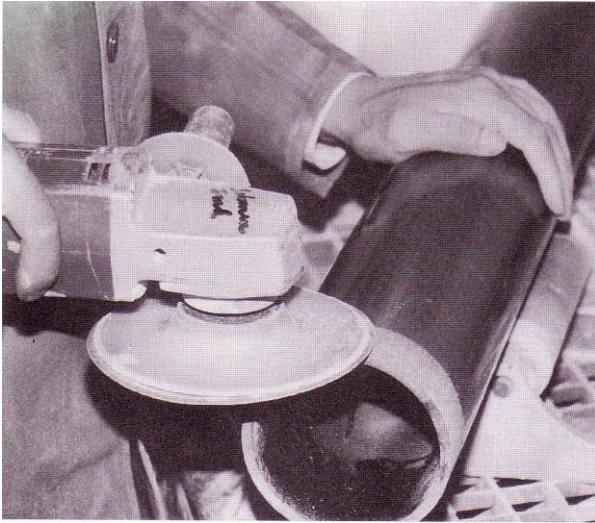
The pipe can be cut into lengths by hand, using a hacksaw. Cut at a right angle to the axis. When cutting freehand it is useful to mark the intersection line before cutting. Cut the pipe all the way through and possibly support the free ends so that breaking before the completion of cutting is prevented.



#### Surface preparation

Good bonding depends on good adhesion between the adhesive and the material to be bonded. Therefore the bonding surface of the pipe and bonded socket ends must be prepared for the adhesive in the correct manner.

### Cylindrical Bonding



Fiberpipe fittings are bonded using cylindrical bonded socket ends. Cylindrical bonding is easy and no special tools are required. Pipe ends are uniformly and thoroughly sanded (extend approx. 10 mm beyond joint area) under dry conditions. This procedure is also applied to the inside and front edge of the bonded socket and the inside of the socket of the end of the fitting. The bonding surface of pipe and fitting must be evenly, thoroughly and dryly roughened with emery cloth respectively an emery mop (graining 40-60).

After sanding, the bonding surfaces should be free of shiny parts. The surfaces are machined smoothly and without large unevenness. The fitting should be pushed smoothly onto the pipe (pipe and fitting should not be jammed). Symmetrically rotating components can be sanded on a dolly. This ensures an evenly sanded surface. The working process is easier and faster.

### Conical Bonding



On demand, filament wound pipe can be pre-fabricated to include both a conical bell and conical spigot end.

Bonding on site requires the following preparations:

Sand manually all bonding surfaces to ensure that all impurity is removed. Inspect and if necessary prepare the bonding surfaces as described above. Conical surfaces may only be sanded manually.

Careful use of grinding machines is permitted, but only if the pipe is installed on rollers and able to rotate.

Remove all excess sand powder using a clean and dry brush. Protect prepared bonding surfaces against dirt, moisture, etc. Grease, oil, or sweat act as parting agents and prevent adhesion.

Do not use solvents to clean bonding surfaces. Bonding surfaces should be prepared immediately before bonding is carried out.

## 1.2. Handling adhesive

### Adhesive XW 1038/1015-2

(Epoxy resin)

Quantity:	560 g
Resin XW1038	380 g
Hardener XW1015-2	180 g

Notice the indicated shelf life: 1 year maximum

For adhesive XW 1038/ XW 1015-2 always mix the total quantities of each unit. Other mixing proportions are not permitted.

The hardener is added to the resin and both components are thoroughly mixed in the container. The adhesive is ready for use when the mixture shows a uniform consistency.

No streaks should be visible.

At low ambient temperatures (less than 15 °C) the resin (component XW1038) should be gently heated since it is otherwise too viscous. At ambient temperatures under 10 °C no bonding should take place without adding heat (e.g. using heat blankets or dryers).

#### Attention!

Make sure to obtain a good mix at the bottom and in the corners of the can. Store adhesive in a dry place. When mixing and using adhesives, observe the safety instructions (see adhesive can DIN safety data sheet).

### Adhesive VE

(Vinyl ester resin)

Quantity per unit:	282,4 g
Resin (Component A):	275,0 g
Hardener (Component B):	7,4 g

The shelf life of the adhesive depends on the storage temperature. At 10° C the shelf life is 6 months minimum (see expiry date on the can).

The hardener is dosed for the total quantity of the adhesive. Usually, the total quantity for each charge is mixed in the can. At higher ambient temperatures one can work by reducing the quantity of the hardener. This extends the pot-life of the adhesive.

Recommended hardener quantities:

- up to 30° C 100 %
- over 30° C 50 %

After adding the hardener, the adhesive is mixed thoroughly. The adhesive is then ready to use when the mixture shows a uniform colour. No streaks should be visible.

At low ambient temperatures (less than 15°C) the resin (component A) should be gently heated since it is otherwise too viscous. At ambient temperatures under 10°C no bonding should take place without adding heat (e.g. using heat blankets or dryers).

#### Attention!

Make sure to obtain a good mix at the bottom and in the corners of the can. Store adhesive in a dry place. When mixing and using adhesives, observe the safety instructions (see adhesive can or DIN safety data sheet).

### Number of adhesive bonds

Nominal Diameter		XW 1038/XW 1015-2	VE
DN 25	1"	25	22
DN 40	1 1/2"	19-20	13-15
DN 50	2"	12-13	9-10
DN 65	2 1/2"	10-11	7-8
DN 80	3"	8-9	6-7
DN 100	4"	5-6	3-4
DN 150	6"	4-5	2-3
DN 200	8"	3-4	1-2
DN 250	10"	1-2	1
DN 300	12"	1	0,5

### Utilization limits (pot life )

The time, in which the adhesive can be used (pot life), and the curing period of the mixed adhesive, depends on the temperature.

When the lifetime (pot life) is exceeded, the adhesive becomes very viscous and lumped. Adhesion of the bonded components is no longer guaranteed. Therefore, it is important that the adhesive is used before the pot life is expired. Bonded components may only be aligned within the pot life.

Temperature [°C]	Pot life [minutes]		Curing period [hours]	
	XW 1038 / XW1015-2	VE	XW 1038 / XW1015-2	VE
5	60	60	60	60*
21	50	45	45	45*
27	25	25	20	2
32	20	15	10	1
38	10	10	5	2/3

\*At these ambient temperatures complete curing is no longer possible. Optimum properties of strength and anti-corrosion are not achieved. Heat curing or heat post curing is necessary (see above)

## Adhesive application



The adhesive mixture is applied to the sanded sections of pipe and fittings. Then, a thin coat of adhesive is rubbed in using some pressure. Subsequently a thicker coat is applied. The thickness of adhesive on the pipe ends should be so large it fills the bonding gap between pipe and fitting. Depending on the nominal diameter, a thickness of 2 to 4 mm should be sufficient.

The cut edges of the pipe should be sealed with a thin coat of adhesive. A thin coat of adhesive is also rubbed into the socket end of the fitting with some pressure. This is followed by an evenly applied coat of adhesive of approx. 1 mm thick.

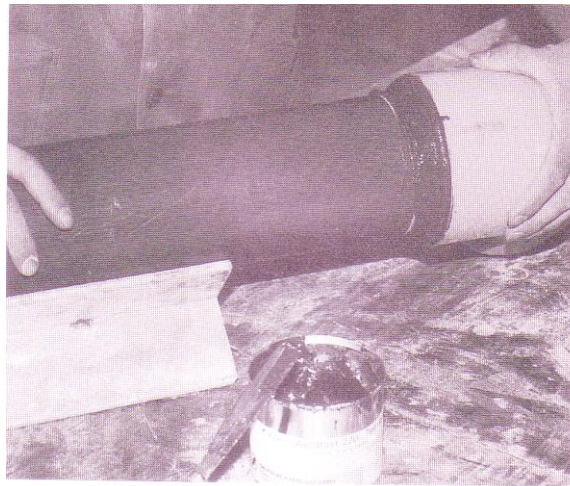
Too many adhesive in the socket end of the fitting is forced inwardly and reduces the cross section area. Therefore, the bead should be kept to a minimum.

### 1.3. Bonding Pipes and Fittings

#### Cylindrical bonding

The fitting is inserted with a slight rotation onto the previously with adhesive coated pipe and pushed until the stopper. In addition the excess of adhesive at the outer edge between socket end and pipe is so removed that a fillet-type cover remains. This bead serves as corner reinforcement.

If needed, the excess of adhesive at the inside of the fitting has to be removed. At accessible areas, a spatula or similar tool is used. On completion of the fitting alignment, care must be taken that the components cannot be dislocated during the curing process.



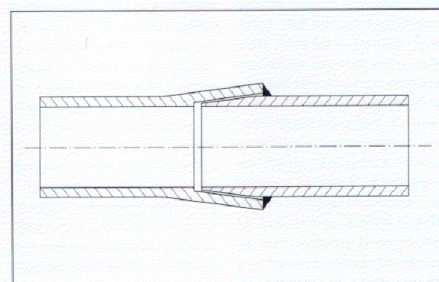
#### Conical bonding

Conical bonds are additionally secured using a clamping device. This results in a bonding gap that is kept to a minimum. It also ensures that the bond remains rigid and cannot loosen when work is carried out at the other end of the pipe. In this way conical bonding is carried out fast and secure. Care must be taken that the clamping device keeps the connection rigid until curing has been completed.

It should be possible to push the fitting gently onto the pipe. The fitting should not be canted because otherwise the adhesive is pushed towards one side.

Alignment of the bonded components can only be carried out within the utilization time (pot life). After this period, the bonded components should not be moved.

The conical spigot ends of a pipe should not be bonded into a fitting with cylindrical bonding socket end.



#### 1.4. Heat curing / post curing

The chemical and mechanical characteristics depend on the curing degree of the bonding. The curing degree can be further increased with an additional post curing. Therefore it makes sense to obtain the curing of the bonding through a higher temperature.

FIBERPIPE heat blankets meet these requirements and are through temperature control adapted in their performance for curing temperatures. The following table shows the recommended temperature and curing periods for heat or post curing.

Heat addition can also be provided using electric radiating heaters or heat gun. To avoid overheating these should be positioned in reasonable distance (depending on the capacity) from the bonding elements.

#### Service instructions for temperature controlled heat blankets

The temperature controlled heat blankets of FIBERPIPE are used for bonding with adhesives XW 1038 / XW 1015-2 or VE to cure faster and better.

Following advices are to be considered:

1. Liquid adhesive remainders on the pipe and fittings surfaces are to be thoroughly removed.
2. Wind a separating foil around the bonding area (e.g. aluminium, copper foil or cellophane).
3. Correct choice of temperature controlled heat blankets and curing period.

#### Dimensions of the heat blanket

Nominal Diameter	Type	Performance	Voltage
25 bis 80	B	135 W	220 V
100 bis 200	C	400 W	220 V
250 bis 350	D	760 W	220 V

#### Curing time

Adhesive	Curing temperature	Curing period
VE	70-80° C	30 min
XW 1038 / XW 1015-2	70-80° C	60 min

### Instruction for using heat blankets

Wind the heat blanket around the element that should be assembled so that the side containing the thermostat of the heat blanket is put first (with the thermo element pointing outward). The rest of the heat blanket end is wound carefully around the part that should be assembled so that the thermostat element is covered completely.

Subsequently the heat blanket is fixed to its position with a VELCRO band or a soft metal band.

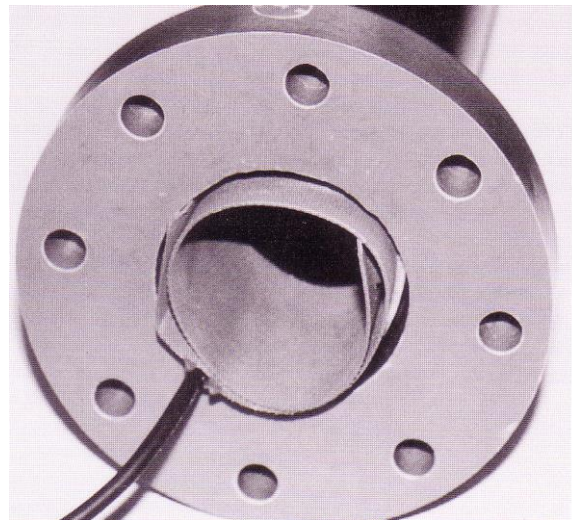
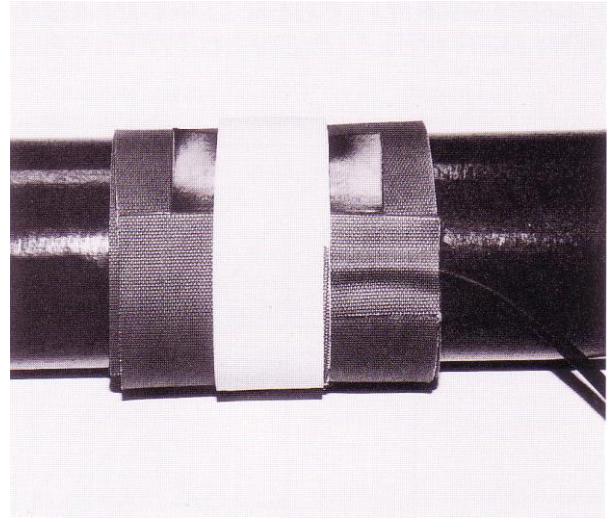
When bonding collars or fixed flanges the heat blanket can be coiled up and slid into the pipe end for heating.

Care should be taken to start with the opposite band ends when winding the thermo element.

With smaller pipe diameter the heat blanket fixes itself, with larger diameter or too much softness, the insertion of a supporting element is recommended (e.g. a GRP pipe section with smaller diameter).

The curing time mentioned in the table above take the preheating time of the cold pipe joint into consideration.

Loss of radiation can be prevented by applying an external thermal insulation to the heat blanket (e.g. corrugated board or similar)



### Attention!

- The heat blanket with controlled temperature cannot be creased either when it is cold or when it is warmed.
- No dissolvent, grease or similar can be used for cleaning as this will affect the silicon rubber.
- Pulling or ripping the connection cable has to be avoided, so that the thermo element is not damaged.
- A wrong width of the heat blanket or inappropriate use can lead to the destruction of the heat blanket respectively the overheating of the assembling element.
- It is forbidden to use the heat blanket under wet conditions (e.g. rain) respectively if there are cracks or holes in the heat blanket.

## 1.5. Special recommendations for environmental influences

### Moisture influences

Care must be taken that the components to be bonded are protected from any kind of moisture (rain, fog, dew, snow) during both preparation and assembly (until curing is completed). These weather influences can be adjusted by using an assembly tent, canvas cover etc. Even when direct moisture such as rain or fog is not observable, depending on the local climatic conditions, a film can be formed on the bonding components through condensation. This occurs when the temperature remains under dew point. The following diagram can be used to determine whether at given local climatic conditions, a temperature inferior to the dew point is possible or not.

Ambient conditions are measured.

The initial values are:

Ambient temperature  $T$ , relative moisture PHI, component temperature  $T_2$

On the basis of the input data  $T$  and PHI the dew point temperature  $T$  is calculated using the diagram. The calculated values allow the following situation analysis:

$T_2 > T$ : condensation is not possible

$T_2 \leq T$ : formation of condensation is possible. The work piece must be warmed to approx.  $5^\circ\text{C} - 10^\circ\text{C}$  above  $T$ .

In general, when processing the components care must be taken to maintain a safety margin in relation to the dew-point temperature. If a work piece is heated, one must be careful that, due to a cooling down during processing, its temperature does not drop below dew point.

### Influences of ambient temperature

The influences of the ambient temperature on the pot life and curing period have already been described in detail above. Also the viscosity of the adhesive is directly dependent on the temperature. By temperatures fewer than  $15^\circ\text{C}$  following advices should be considered.

XW 1038 / XW 1015-2

At temperatures fewer than  $15^\circ\text{C}$  it makes sense to preheat the resin; otherwise no adequate mixture can be produced. Furthermore it is difficult, even almost impossible to rub the adhesive into the surface.

One must keep in mind that also the pipe temperature affects the viscosity of the adhesive. If for example, preheated adhesive is applied at a temperature under approx.  $10^\circ\text{C}$ , the coating of the adhesive will cool down very rapidly, resulting in a higher viscosity. A remedy is to preheat the pipe ends. Mind that the increased pipe temperature affects the pot life of the applied adhesive.

At ambient temperature below  $10^\circ\text{C}$ , we recommend to work in a heated tent or shop area. Heating pipe ends, fitting sockets and adhesive is possible, but not always recommended.

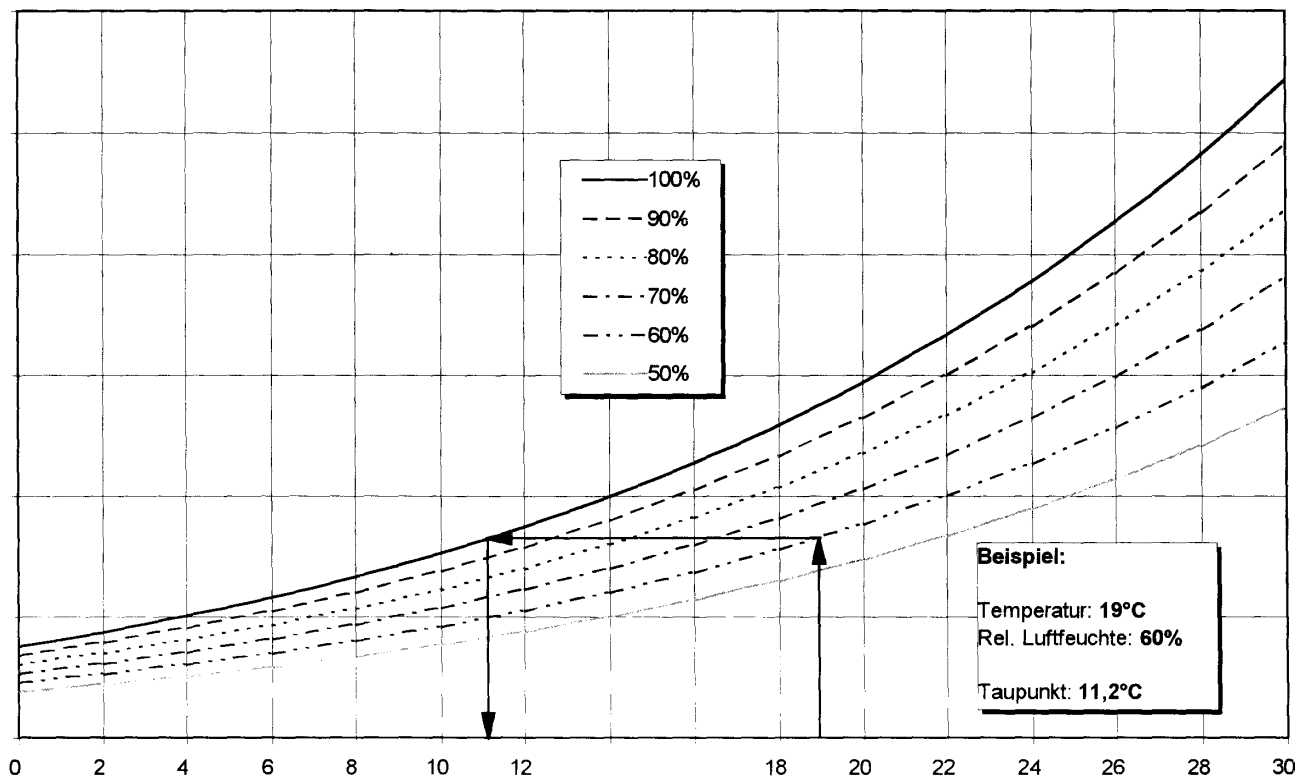
## VE

At temperatures under 15°C, it makes sense to slightly preheat the resin (at max. 20°C), before using it. Reason here is that the viscosity changes depending on the temperature as already outlined above. At temperatures under 10°C, it does not make sense to bond without additional heating. Working in heated shop areas is recommended.

If the ambient temperature increases till over 30°C it is possible with adhesive VE, to extend the pot life by reducing the quantity of the hardener. Recommendations for quantities are outlined above.

The adhesive and the condition of the bonding surface only determine the resistance of the bonding. The pipe material (epoxy resin, vinyl ester resin or metal) has no effect.

These instructions have been produced on the basis of a wide range of practical experience. Depending on the site conditions and the experience of the personnel, questions may arise which have not been dealt with in this document. If so, please consult our applications technology department.

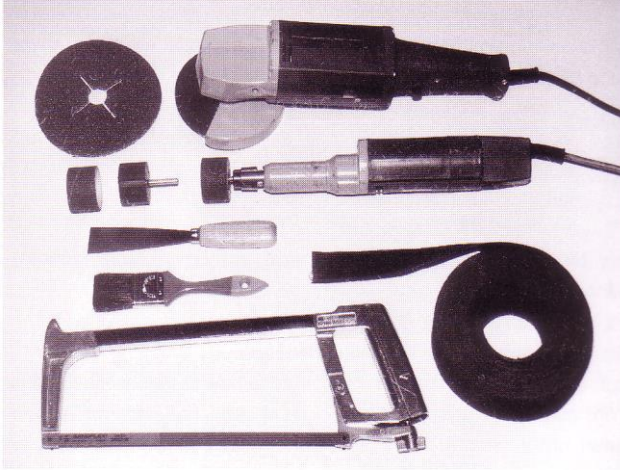


**WATER CONTENT OF THE AIR IN RELATION WITH THE RELATIVE MOISTURE**  
**Determination of the dew-point temperature**

## 2. Lamination technique

### 2.1 Working procedures

Thorough preparation before starting to laminate will ensure that the work can proceed smoothly. This includes amongst others cutting the needed glass mats and glass fabric and the allocation of the required quantities of resin and hardener.



#### Cutting pipes

The pipe can be cut into lengths by hand using a hacksaw. Cut at a right angle to the axis. When cutting freehand it is useful to mark the intersection line before cutting. Cut the pipe all the way through and possibly supports the free ends so that breaking before the completion of cutting is prevented.

#### Surface preparation

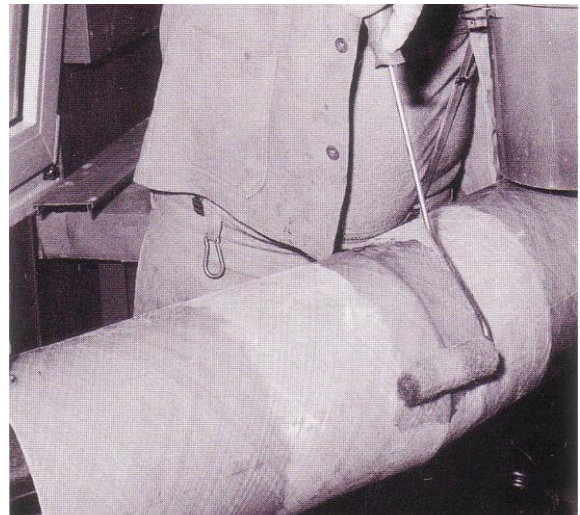
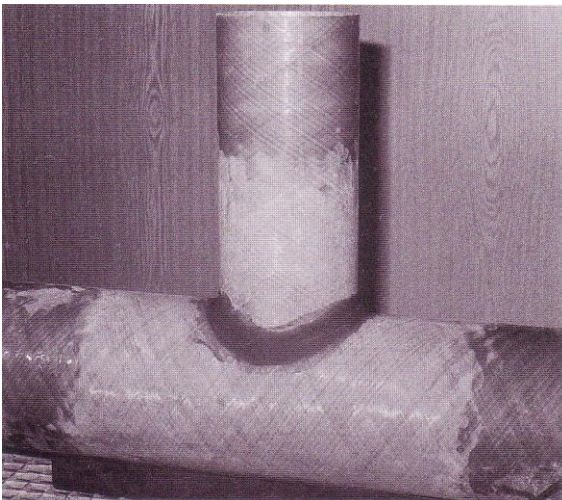
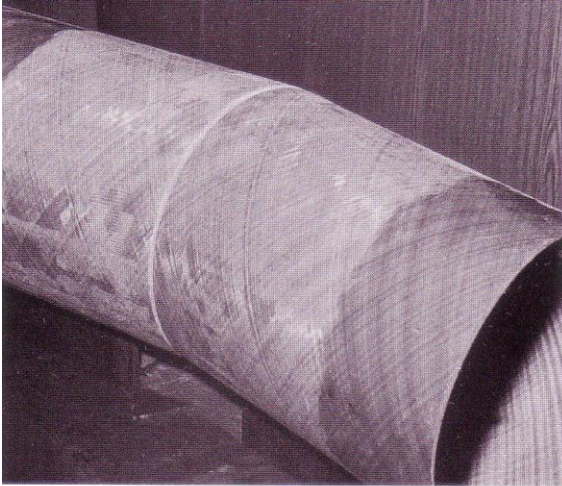
The surface of the pipe and other GRP components that are to be laminated must be sanded before the laminate material is applied. The length of the sanded pipe surface should be 2-5 cm longer than the length of the lamination. When sanding is completed, the surface should be free of shiny areas. Excess sand powder is removed using a clean and dry brush. **If interior lamination is to be done, the inside surfaces must be treated correspondingly.**

Protect prepared surfaces from dirt, moisture, etc... Grease, oil, or sweat act as parting agents and prevent adhesion of the lamination. Do not use solvents to clean the surfaces to be laminated.



### Aligning of components

The pipe components that need to be connected must be secured so that they remain correctly aligned during lamination and the curing period. The cut edges of the pipe and fittings are covered with adhesive XW 1038 / XW 1015-2 (epoxy resin) or VE (vinyl ester resin) and are herewith sealed. After joining, the remaining gap is filled with adhesive. Hereafter, a fixed lamination of mat and resin can be applied. When the lamination is cured properly, the fixed lamination respectively the adhesive is sanded again, prior to lamination.

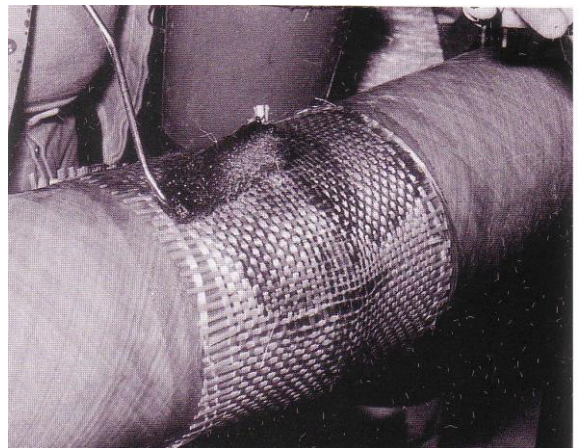
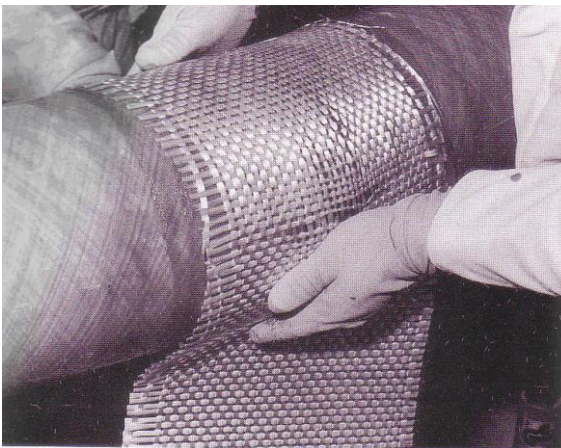
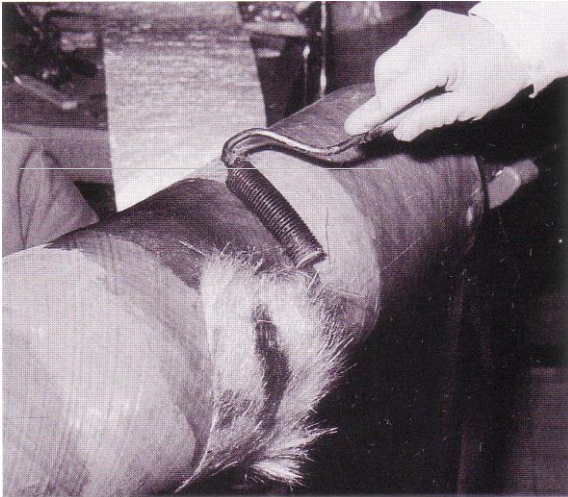


### Lamination procedure

The glass mats and glass fabrics are cut and the resin mixture prepared for the lamination process. The resin is applied to the prepared surface using a lambskin roller.

Next, the first glass mat is applied, saturated with lamination resin and rolled with a roller. The second layer is processed similarly. Rolling is carried out using a de-airing roller, e.g. steel grooved roller. By winding a layer of glass silk tape onto the lamination, the lamination is densified. The glass silk tape must be applied evenly with an overlap of approx. 50% and well soaked with resin.

Accordingly the following lamination layers are applied in a modular way. Then again resin is applied to the existing lamination with the lambskin roller; a layer of glass fabric is applied, impregnated with resin, and rolled with a roller to remove the air. The mat layer is applied in a similar way. The new lamination layers are densified with glass silk tape. Also here care must be taken that the glass silk band is with a 50 % overlap winded and well impregnated.



### Attention!

Soak glass reinforcement completely with laminate resin. Roll lamination layers airtight with a de-airing roller. Wind glass silk tape tight and evenly onto lamination layers.

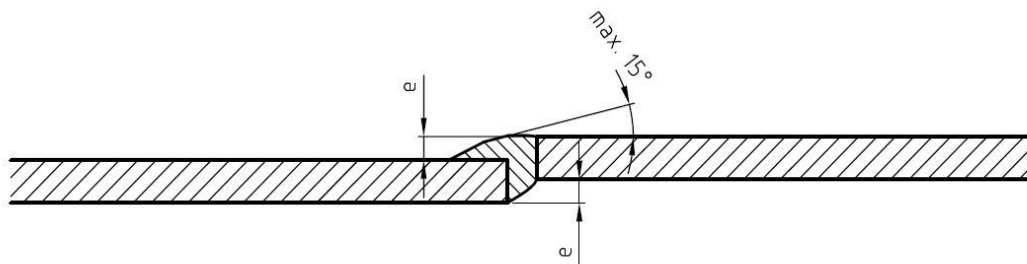
### Displace of butt lamination

If pipes of a large diameter are highly noncircular, care must be taken that with a proper fastening device (depending on the nominal diameter and wall thickness) the displacement is kept smaller than the values shown in the following table.

Nominal Diameter	350	400	500	600	700	750	800	1000
Displacement (mm)	4,5	5,0	5,5	6,5	7,5	8,0	8,5	6,0

Table 1: allowed pipe displacement

The transfer area should be softly aligned with adhesive.  
The inclination angle should be less than 15°.



For pipes with a nominal diameter that allow inside work, an internal lamination can be applied to improve the corrosion resistance.

## 2.2 Mixing standard resins

For lamination work with epoxy resin respectively vinyl ester resin, we recommend for standard conditions the following resin mixtures.

<b>Epoxy resin</b>	<b>Vinyl ester resin</b>
1000 parts resin EPIKOTE 827 180 parts hardener Aradur 5003-1	1000 parts resin 411-45 30 parts hardener MEKP-M 60 15 parts accelerator 1 % cobalt

Components that are not yet mixed, such as resin, hardener and accelerator, require appropriate storage. Inappropriate storage reduces storage life and results in a chemical modification of the raw material. Thus later handling is no longer possible, respectively mentioned storage times are shortened.

<b>Storage temperature</b>	<b>Epoxy resin</b>	<b>Vinyl ester resin</b>
25° C	up to 2 years	up to 6 months

### Attention!

Hardener and accelerator must be stored separately and always measured or weighed in separate containers. Do not mix them directly with each other.

More important information about handling resin, hardener, and accelerator is to be considered in regard with the current local security regulations.

### Reaction times during processing Processing times under standard conditions

At ambient temperatures of approx. 20°C and a laminate thickness of 8-10 mm following processing times can be expected for a standard resin mixture:

<b>Operation</b>	<b>Epoxy resin</b>	<b>Vinyl ester resin</b>
Resin and hardener are mixed	0 min	0 min
Resin begins to gel	20-30 min	20-30 min
Gelled components begin to warm up	30-40 min	30-40 min
Exothermic temperature peak	2-3 hours	50-70 min
Cold and solid	3-6 Hours	70-120 min
Curing up to full mechanical resistance	seen section "curing procedure"	

## Working with various ambient temperatures and large laminate thicknesses

With a standard resin mixture the cross-linking reaction goes faster at higher ambient temperatures. This means that laminate connections must be completed in less time. Also, since the exothermic cross-linking reaction sets heat free, overheating may occur, depending on the ambient temperature and the thickness of the lamination.

This must be avoided. When working at temperatures over 25°C or with larger laminate thickness, steps must be taken to extend the lamination period and to slow down the curing period.

### Vinyl ester resin laminates

The reaction speed is controlled by the ratio resin/hardener/accelerator and can be modified according to the ambient temperature or lamination thickness. The following table provides guidelines for possible mixture ratios (by weight) at various temperatures and lamination thickness.

Mixture ratios for laminates up to approx. 12 mm

Working temperature	Resin part	Hardener part	Accelerator part
10°C - 15°C	1000	30	15
15°C - 20°C	1000	30	15
20°C - 25°C	1000	30	10
25°C - 30°C	1000	30	5

Mixture ratios for laminates up to approx. 12-20 mm

Working temperature	Resin part	Hardener part	Accelerator part
10° C - 15° C	1000	30	15
15° C - 20° C	1000	30	10
20° C - 25° C	1000	30	5
25° C - 30° C	1000	30	3

These guidelines can be adapted to special boundary conditions or the lamination experience of operatives. The portion of hardener or accelerator should be within the limit values as shown above. Thicker laminates can be completed using intermediate curing.

### Epoxy resin laminates

In the case of epoxy resin, a modification of the mixture ratio is not allowed. A well-defined mixture ratio is a precondition for an optimal curing. At higher ambient temperatures the reaction speed cannot be shortened or extended by modifying the mixture ratio.

At higher ambient temperatures, or with thicker laminates, intermediate curing is required.

## 2.3 Curing process

### Standard curing

The curing period for a laminated joint depends on the ambient temperature, respectively the temperature that arises in the lamination during the curing process.

The following curing periods are to be expected for a lamination of approx. 10 mm thickness with a standard resin mix:

Ambient temperature respectively curing temperature	Epoxy resin	Vinyl ester resin
ca. 20°C	ca. 18 h	ca. 24 h
ca. 50°C	ca. 2 h	ca. 5 h
ca. 80°C	ca. 1 h	ca. 1,5 h

### Post curing

The mechanical strength and chemical corrosion resistance of a lamination depends on the reached curing degree. The more perfect the curing, the higher the values reached. If curing takes place at room temperature, tempering the post curing is required in order to ensure a high quality connection. Therefore it makes sense to attain the curing of the connection by evenly and controlled higher temperatures. Fiberpipe heat blankets meet these conditions and through their ability to control the temperature adjusted to curing temperatures.

If too much heat is introduced before or during the gelling phase, the viscosity of the resin is reduced. The resin will flow out of the joint and the reinforcing fibres are no longer saturated. Additional heat should be supplied evenly and controlled. Overheating of the lamination must be prevented as overheated laminates have reduced strength and inferior chemical resistance.

Under normal conditions, post curing should take place at:

- Epoxy resin:                   80° C - 100° C           duration 60 min
- Vinyl ester resin:           80° C - 95° C           duration 90 min

Maximal temperatures in case of thermal post curing:

- Epoxy resin:                   150° C
- Vinyl ester resin:           95° C

### Curing of larger lamination thicknesses

Heat is produced during the curing period. The thicker the lamination, the more heat is set free. If the lamination is too thick it can lead to an overheating of the lamination. This should be avoided for the above-mentioned reasons.

In such a case it can be necessary to work with intermediate curing. Hereby half of the required wall thickness is first built and cured. Then the surface is sanded and the remaining lamination, according to the specified lamination construction, built until the final wall thickness is reached and cured.

## 2.4 Environmental influences

### Moisture influences

The components to be laminated must be protected from moisture (rain, fog, dew and snow) during the whole working process.

Using appropriate assembly tents and heating devices can prevent this. The formation of condensation due to the temperature difference between work piece and ambient temperature must be avoided.

An existing pipeline containing liquid must be completely dried up before repairing. No liquid may seep through at the location under repair. Even the smallest quantities are damaging.

### Ambient temperature influences

The influences on processing time and curing periods have already been described in detail. One also needs to consider that the viscosity of the lamination resin is dependent on ambient temperature.

Especially for epoxy resin, the impregnation properties of the glass fabric and glass mats are dependent on the resin temperature. Therefore it is meaningful that for ambient temperatures less than 15°C the resin and hardener are heated to approx. 22°C prior to mixing. Care must be taken that pre-heating is not too high, since processing time is otherwise considerably reduced.

## 2.5 Safety measures

- Avoid all contact with the hardener. In case of contact wash the skin thoroughly with soap and water!
- Resin, hardener and solvents are inflammable. Therefore, smoking and handling of open fire are forbidden!
- Hardener and accelerator must not be brought into contact with each other! Risk of explosion!
- The local safety rules in force for polyester and epoxy resins are to be taken into account.

The mechanical resistance of a lamination connection is determined only by the lamination applied and the consistency of the surface. The pipe material (epoxy resin, vinyl ester resin or metal) has no effect.

These instructions have been produced on the basis of a wide range of practical experience. Depending on the site conditions and the experience of the personnel, questions may arise which have not been dealt with in this document. If so, please consult our applications technology department.

## 2.6 Lamination construction

### Butt lamination construction

Butt lamination PN 6

External lamination according DIN 16966, Part 8:  $\sigma_{zul} = 150\text{N/mm}^2$   
Glass content (45±10) %

DN	S [mm]	Dimensions of cut pieces			Lamination construction
		B [mm]	L [mm]	Tape* width [mm]	
150-300	see PN 10 DN 150-300				
350	5,0	170	1200	100	2(MGB) + M'
400	5,0	200	1360	100	2(MGB) + M'
450	7,1	220	1530	100	3(MGB) + M'
500	7,1	240	1700	100	3(MGB) + M'
600	7,1	290	2030	100	3(MGB) + M'
700	9,2	335	2370	100	4(MGB) + M'
800	9,2	370	2700	100	4(MGB) + M'
900	11,3	430	3030	100	5(MGB) + M'
1000	11,3	460	3350	100	5(MGB) + M'
1100	13,4	510	3690	100	6(MGB) + M'

Butt lamination PN 10

External lamination according DIN 16966, Part 8:  $\sigma_{zul} = 150\text{N/mm}^2$   
Glass content (45±10) %

DN	S [mm]	Dimensions of cut pieces			Lamination construction
		B [mm]	L [mm]	Tape* width [mm]	
25-125	see PN 16 DN 25-125				
150	3,5	130	540	100	MGB + 1 (MB) + M'
200	5,0	165	720	100	2(MGB) + M'
250	5,0	205	870	100	2(MGB) + M'
300	7,1	250	1080	100	3(MGB) + M'
350	7,1	290	1220	100	3(MGB) + M'
400	9,2	300	1400	100	4(MGB) + M'
450	11,3	350	1560	100	5(MGB) + M'
500	11,3	410	1720	100	5(MGB) + M'
600	13,4	460	2060	100	6(MGB) + M'
700	13,4	525	2400	100	6(MGB) + M'
800	15,5	625	2750	100	7(MGB) + M'
900	17,6	700	3080	100	8(MGB) + M'
1000	19,7	750	3400	100	9(MGB) + M'
1100	21,8	850	3900	100	10(MGB) + M'

Butt lamination PN 16

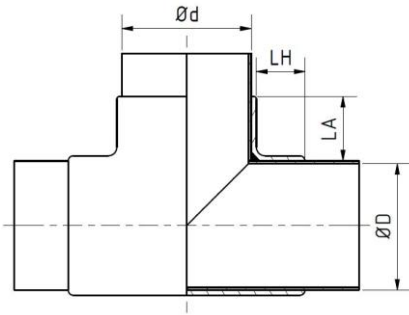
External lamination according DIN 16966, Part 8:  $\sigma_{zul} = 150\text{N/mm}^2$

Glass content (45±10) %

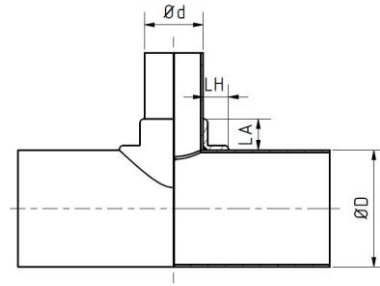
DN	S [mm]	Dimensions of cut pieces			Lamination construction
		B [mm]	L [mm]	Tape* width [mm]	
25	3,5	50	120	100	MGB + 1(MB) +M'
40	3,5	50	180	100	MGB + 1(MB) +M'
50	3,5	75	200	100	MGB + 1(MB) +M'
65	3,5	75	250	100	MGB + 1(MB) +M'
80	3,5	110	310	100	MGB + 1(MB) +M'
100	5,0	140	380	100	2(MGB) + M'
125	5,0	175	470	100	2(MGB) + M'
150	5,0	210	550	100	2(MGB) + M'
200	7,1	250	750	100	3(MGB) + M'
250	7,1	300	900	100	3(MGB) + M'
300	9,2	375	1100	100	4(MGB) + M'
350	11,3	425	1250	100	5(MGB) + M'
400	13,4	500	1450	100	6(MGB) + M'
450	13,4	550	1600	100	6(MGB) + M'
500	15,5	600	1750	100	7(MGB) + M'
600	19,7	745	2100	100	9(MGB) + M'
700	21,8	880	2450	100	10(MGB) + M'
800	23,9	990	2800	100	11(MGB) + M'
900	28,1	1115	3150	100	13(MGB) + M'
1000	30,2	1235	3450	100	14(MGB) + M'

- M: mat (450 g/m<sup>2</sup>)
- G: fabric (720 g/ m<sup>2</sup>), 1:1
- B: glass silk tape 116 (220 g/m<sup>2</sup>)
- \*: 4 rounds intertwined
- M': mat torn (580 g/m<sup>2</sup>)

### Lamination construction – Branch lamination



Picture 1: Branch lamination: tubular form (R)



Picture 2: Branch lamination: circular form (K)

Selection of lamination form:

Nominal pressure      PN 10  
 Tubular form             $d > 0,4 D$   
 Circular form             $d \leq 0,4 D$

DN Main pipe	Branch pipe																			
	25	40	50	65	80	100	125	150	200	250	300	350	400	450	500	600	700	800	900	1000
40	R	R																		
50	R	R	R																	
65	K	R	R	R																
80	K	K	R	R	R															
100	K	K	R	R	R	R														
125	K	K	K	R	R	R	R													
150	K	K	K	R	R	R	R	R												
200	K	K	K	K	K	R	R	R	R											
250	K	K	K	K	K	K	R	R	R	R										
300	K	K	K	K	K	K	R	R	R	R	R									
350	K	K	K	K	K	K	K	R	R	R	R	R								
400	K	K	K	K	K	K	K	K	R	R	R	R	R							
450	K	K	K	K	K	K	K	K	R	R	R	R	R	R						
500	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R					
600	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R				
700	K	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R			
800	K	K	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R		
900	K	K	K	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R	
1000	K	K	K	K	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R
1100	K	K	K	K	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R

Table 1: Selection of circular form (K) or tubular form (R) reinforcement PN 10

Selection of lamination form:

Nominal pressure      PN 16  
 Tubular form             $d > 0,25 D$   
 Circular form             $d \leq 0,25 D$

DN Main pipe	Branch pipe																
	25	40	50	65	80	100	125	150	200	250	300	350	400	450	500	600	700
40	R																
50	R	R															
65	R	R	R														
80	R	R	R	R													
100	K	R	R	R	R												
125	K	R	R	R	R	R											
150	K	R	R	R	R	R	R										
200	K	K	K	R	R	R	R	R									
250	K	K	K	R	R	R	R	R	R								
300	K	K	K	K	R	R	R	R	R	R							
350	K	K	K	K	K	R	R	R	R	R	R						
400	K	K	K	K	K	K	R	R	R	R	R	R					
450	K	K	K	K	K	K	K	R	R	R	R	R	R				
500	K	K	K	K	K	K	K	R	R	R	R	R	R	R			
600	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R		
700	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R	R	R
800	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R	R
900	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R	R
1000	K	K	K	K	K	K	K	K	K	K	R	R	R	R	R	R	R

Table 2: Selection of circular (K) or tubular form (R) reinforcement PN 16

Main pipe DN	DN	Branch pipe																		
		25	40	50	65	80	100	125	150	200	250	300	350	400	500	600	700	800	900	1000
350	Lamination type	A	A	A	A	A	A	B	B	B	B									
	LH (mm)	50	50	50	50	75	75	100	100	100	125	150								
400	Lamination type	A	A	A	A	B	B	B	B	C	C	C								
	LH (mm)	50	50	75	50	75	75	100	100	100	125	150	150							
450	Lamination type	B	B	B	B	B	B	C	C	C	C	D	D	D						
	LH (mm)	75	75	75	75	75	75	100	100	100	125	150	150	175						
500	Lamination type	B	B	B	B	C	C	C	C	D	D	D	D	D						
	LH (mm)	75	75	75	75	75	75	100	100	100	125	150	150	175						
600	Lamination type	B	B	B	C	C	C	C	D	D	D	D	D	E	E					
	LH (mm)	75	75	75	75	75	100	100	100	100	125	150	150	175	175					
700	Lamination type	B	B	C	C	C	C	D	D	D	D	D	E	E	E	G				
	LH (mm)	100	100	100	100	100	100	100	100	100	125	150	150	175	175	225				
800	Lamination type	C	C	C	C	D	D	D	D	D	E	E	E	G	G	P	P	P		
	LH (mm)	100	100	100	100	100	100	100	100	100	125	150	150	175	175	250	250	250		
900	Lamination type	C	C	D	D	D	D	D	E	E	E	G	G	P	P	Q	Q	Q		
	LH (mm)	100	100	100	100	100	100	100	100	100	125	150	150	175	175	250	250	250		
1000	Lamination type	C	D	D	D	D	D	E	E	E	G	G	P	P	Q	Q	Q	Q	R	R
	LH (mm)	100	100	100	100	100	100	100	100	125	150	150	175	175	225	250	250	250	250	250
	LA (mm)	50	50	50	50	50	50	50	50	50	75	75	100	100	125	150	150	150	225	250

Table 3: Laminate dimensions branch lamination PN 16

Main pipe DN	DN	Branch pipe																		
		25	40	50	65	80	100	125	150	200	250	300	350	400	500	600	700	800	900	
40	Lamination type LH (mm) LA (mm)	A 50 50																		
50	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50																	
65	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	A 50 50																
80	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	A 50 50	A 50 50															
100	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	A 50 50	A 50 50	A 75 75														
125	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	A 50 50	B 50 50	B 75 75	C 75 75													
150	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	A 50 50	A 50 50	A 75 75	A 75 75	B 100 75												
200	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	A 50 50	A 50 50	A 75 75	B 75 75	B 100 75	B 120 75											
250	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	A 50 50	A 50 50	B 75 75	B 75 75	L 100 75	M 120 75	N 140 100										
300	Lamination type LH (mm) LA (mm)	A 50 50	A 50 50	B 50 50	B 50 50	C 75 75	L 75 75	M 100 75	M 120 75	N 140 100	O 180 120									
350	Lamination type LH (mm) LA (mm)	A 50 50	B 50 50	B 50 50	C 50 50	L 75 50	M 75 50	M 100 50	M 100 50	N 125 75	O 150 100	O 175 100								
400	Lamination type LH (mm) LA (mm)	B 50 50	B 50 50	C 75 50	L 75 50	M 75 50	M 75 50	M 100 50	N 100 50	O 125 75	O 150 100	O 175 100	P 200 125							
450	Lamination type LH (mm) LA (mm)	B 75 50	C 75 50	L 75 50	M 75 50	M 75 50	M 75 50	N 100 50	O 100 50	O 125 75	O 150 100	P 175 100	P 200 125	P 225 125						
500	Lamination type LH (mm) LA (mm)	C 75 50	C 75 50	M 75 50	M 75 50	M 75 50	N 75 50	N 100 50	O 100 50	O 125 75	P 150 100	P 175 100	P 200 125	Q 225 125						
600	Lamination type LH (mm) LA (mm)	C 75 50	M 75 50	M 75 50	M 75 50	N 75 50	N 100 50	O 100 75	O 100 75	P 125 75	P 150 100	P 175 100	Q 200 125	Q 225 125	R 250 150					
700	Lamination type LH (mm) LA (mm)	M 100 50	M 100 50	M 100 50	N 100 50	N 100 50	O 100 50	O 100 75	P 100 75	P 125 75	P 150 100	Q 175 100	Q 200 125	R 225 125	R 250 150	S 300 200				
800	Lamination type LH (mm) LA (mm)	M 100 50	M 100 50	N 100 50	N 100 50	O 100 50	O 100 50	P 100 75	P 100 75	P 125 75	Q 150 100	Q 175 100	R 200 125	R 225 125	S 250 150	S 350 200	U 350 200			
900	Lamination type LH (mm) LA (mm)	M 100 50	N 100 50	N 100 50	O 100 50	O 100 50	P 100 50	P 100 75	P 100 75	Q 125 75	Q 150 100	R 175 100	R 200 125	S 225 125	S 250 150	U 350 200	U 350 200	V 375 225		
1000	Lamination type LH (mm) LA (mm)	N 100 50	N 100 50	O 100 50	O 100 50	P 100 50	P 100 50	P 100 75	Q 100 75	Q 125 75	R 150 100	R 175 100	S 200 125	S 225 125	U 250 150	U 350 200	V 350 225	V 375 250	W 375 250	

Table 4: Laminate dimensions branch lamination PN 10

Main pipe DN	DN	Branch pipe										
		25	40	50	65	80	100	125	150	200	250	
40	Lamination type	A										
	LH (mm)	50										
	LA (mm)	50										
50	Lamination type	A	A									
	LH (mm)	50	50									
	LA (mm)	50	50									
65	Lamination type	A	A	A								
	LH (mm)	50	50	50								
	LA (mm)	50	50	50								
80	Lamination type	A	A	A	A							
	LH (mm)	50	50	50	50							
	LA (mm)	50	50	50	50							
100	Lamination type	A	A	A	A	A						
	LH (mm)	50	50	50	50	75						
	LA (mm)	50	50	50	50	75						
125	Lamination type	A	A	A	A	A	A					
	LH (mm)	50	50	50	50	75	75					
	LA (mm)	50	50	50	50	75	75					
150	Lamination type	A	A	A	A	A	A	B				
	LH (mm)	50	50	50	50	75	75	100				
	LA (mm)	50	50	50	50	75	75	75				
200	Lamination type	A	A	A	A	A	B	B	B			
	LH (mm)	50	50	50	50	75	75	100	120			
	LA (mm)	50	50	50	50	75	75	75	75			
250	Lamination type	A	A	A	A	B	B	L	M	N		
	LH (mm)	50	50	50	50	75	75	100	120	140		
	LA (mm)	50	50	50	50	75	75	75	75	100		
300	Lamination type	A	A	B	B	C	L	M	M	N	O	
	LH (mm)	50	50	50	50	75	75	100	120	140	180	
	LA (mm)	50	50	50	50	75	75	75	75	100	120	

Table 5: Laminate dimensions branch lamination PN 6

Type	Structure	Thickness (mm)
A	M+2xGM	5,5
B	M+3xGM	7,5
C	M+4xGM	9,5
D	M+5xGM	11,5
E	M+6xGM	13,5
F	M+7xGM	15,5
G	M+8xGM	17,5

Table 6: Lamination constructions (M: mat; 450 g/m<sup>2</sup>) (G: fabric; 580 g/m<sup>2</sup>)

Type	Structure	Thickness (mm)
L	M+4xGM	9,5
M	M+5xGM	11,5
N	M+6xGM	13,5
O	M+7xGM	15,5
P	M+8xGM	17,5
Q	M+9xGM	19,5
R	M+10xGM	21,5
S	M+11xGM	23,5
T	M+12xGM	25,5
U	M+13xGM	27,5
V	M+14xGM	29,5
W	M+15xGM	31,5

Table 7: Laminate constructions (M: mat; 450 g/m<sup>2</sup>) (G: fabric; 580 g/m<sup>2</sup>)

### **3. Transports and storage**

#### **3.1 General instructions**

To ensure that FIBERPIPE GRP components are handled safely and appropriately, it is important to handle correctly for transporting, loading, unloading, and storing the goods. These instructions have been produced based on practical experience and is meant to provide practice related advice. Main guidelines, rules for accident prevention and transport insurance regulations must be given priority.

#### **3.2 Entry and intermediate controls**

##### Entry control

Components delivered to the plant or construction site are to be inspected immediately for transportation damage. Any damaged components are best stored separately. Recording of facts and transport damage reports should be established in the presence of the carriers and countersigned.

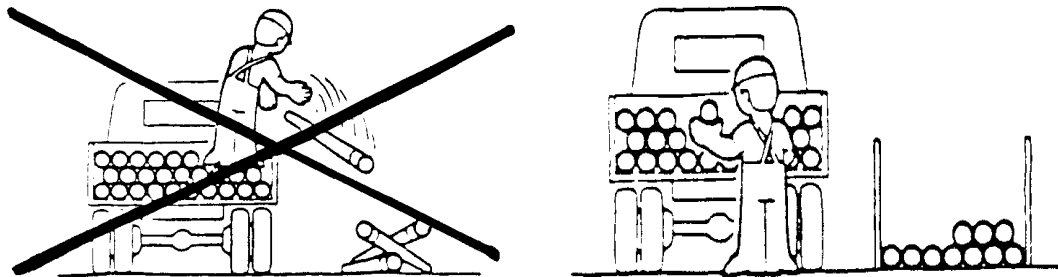
##### Intermediate control

Personnel commissioned to handle FIBERPIPE material should, in their own interest, inspect the material on possible storage damages before any further processing. This is particularly reasonable for long storage periods on site, after internal transportation and during transfer from one department to another. Intermediate control takes the form of a short visual check. This ensures that only faultless material is used.

### 3.3 transportation and handling

#### Loading and unloading on site

Throwing or dragging the floor with GRP components and GRP-lined devices should, as a matter of principle not be done. When loading and unloading, appropriate lifting equipment or an adequate number of personnel should be used. Because of their low weight, a wide range of FIBERPIPE components can be unloaded manually. For cumbersome or large volume components lifting equipment should be used. Points of concentrated load have to be avoided. For this reason, light-lifting devices such as plastic ropes or web belt should be used. Under no circumstances can chains or wire ropes be used. When applying the lifting devices, care must be taken to obtain a good weight partitioning. For cumbersome components lifting eyes are to be used with traverses. In no case ropes can be twined around sockets. The general health and safety regulations for lifting loads are to be followed. Impact load by depositing, displacing, swinging or piling is to be avoided!

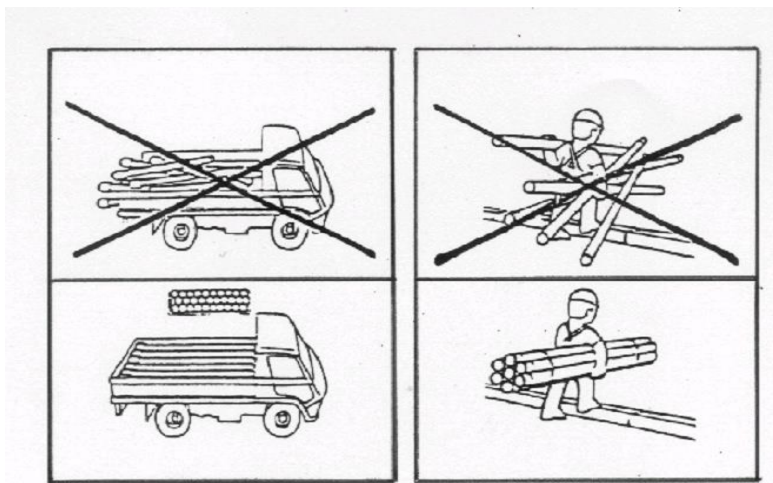


### Intermediate transportation

In case of long transportation routes or longer transport time on factory premises or construction sites, following must be observed:

Smaller components, such as fittings, are to be transported in stiff cardboard boxes, crates or other containers. When transporting over uneven terrain, such as open country, a soft mat e.g. corrugated cardboard, excelsior etc. protects the components against impact load and friction points.

Long and cumbersome components, such as entire pipe lengths, prefabricated isometric components or larger fittings should be attached on vehicles so that no slipping, scouring, bouncing or dropping is possible. Avoid hard and uneven supports. A soft intermediate layer disperses the bearing strength and decreases the friction. The transport of the components is safer.



Excessive overhang of the transportation goods over the vehicle-end is to be avoided. Through this, heavy bending stress can arise due to transport vibrations. In general, attention must be paid that transport containers, crates, boxes and loading spaces are freed from any sharp, protruding edges. Protruding nails, screws, metal strips and profiles must be removed or padded.

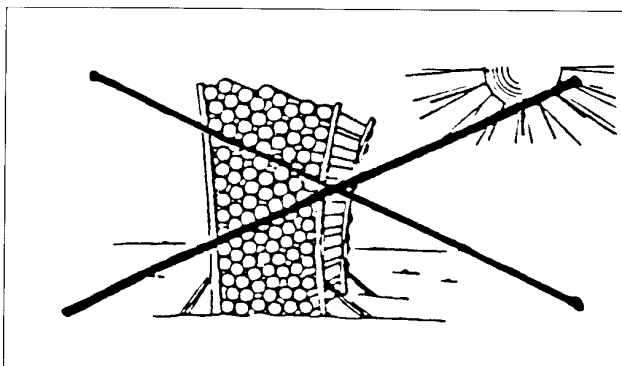
## Handling at construction site

When handling components on site, by pre-assembly and final assembly, following instructions for a quality conscious handling are to be considered:

- When manually transporting entire pipe lengths (6 or 12 m) excessive bending or teeting is to be avoided. If necessary appoint more than two persons.
- Several persons should unload cumbersome semi-finished products or pre-fabricated isometric components, even light weighted.
- Do not drag plastic components over sharp edges or across the floor.
- When transporting avoid abutting steel supports, stairs and other equipment. Put shock-free to the floor.
- Rolls from rotation symmetric components should only be put on stone-free surfaces. When storing, secure against rolling by using e.g. wedges. Larger components or pipes should not be put down on their edges. For cumbersome parts and containers appropriate lifting equipment with supports and lifting accessories should be used.

## 3.4 Storage

After delivery it is appropriate to transport the material immediately to a prepared construction site storage location or into the factory store. If on site a longer intermediate storage period is necessary, it is best to keep the components in their unbroken delivery packing. Fittings and pipes can be stored in pipe palettes in open-air. In case of extreme ambient conditions, appropriate protective measures must be taken. If components are not stored in their original packaging, they are best stored on an even, smooth and stone-free basis. Fittings can be stored on wooden shelves. A storage pile can be used to store pipes. Square-shaped timber can be used as basis. The span between supports must be appropriate to the nominal diameter of the pipe. Pipe stacks can have a maximum height of 1,5 m. For safety reasons lower storage heights are preferred. Pipe stacks must be secured at the side, so that dislocation is not possible. In between each pipe layer sufficient wooden slats must be inserted.



Adhesive must be protected against moisture, extreme heat and cold. The maximum storage time and storage temperature of the different products is to be respected. When selecting the storage area, in one's own interest, one should take care that it is protected against site traffic and external impact.

### 3.5 Damage assessment

If defects are detected on FIBERPIPE components, it is important to make a correct assessment, so that no erring measures are conducted. It is appropriate to distinguish two categories.

#### Surface damage

FIBERPIPE pipes and fittings are provided with an external resin-rich surface coating. If there are visible signs of abrasion, scratches or traces of grinding, these do not effect the lifetime of the components.

#### Laminate damage

At impact locations, circular or star-shaped cracks, emanating from the centre of the point of impact are visible. This kind of damage is not limited to the outer surface, but penetrates deeper into the supporting laminate. Such damage is provoked by severe impact or shock. In general, at low temperatures, especially at temperatures below zero, GRP components are imperilled to impact. However, FIBERPIPE glass-fibre reinforced components are, because of the different material composition, far less exposed than thermoplastic material. Protective measures, however, can do no harm. FIBERPIPE recommends under these circumstances to especially consider, that the advices as described above are kept. Construction components with lamination defects can initially not be used.

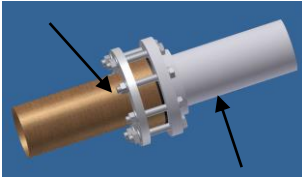
#### 4. General processing and installation instructions

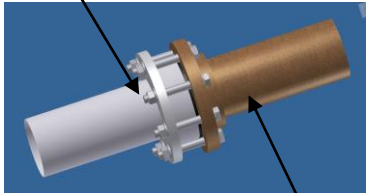
##### 4.1 Time required for handling Fiberpipe pipe systems

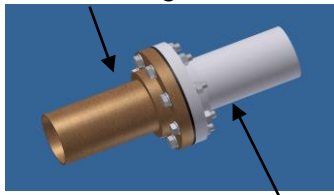
The indicated required time is valid for normal conditions.  
For assembling in difficult conditions, e.g. cold, moisture, the times must be adapted accordingly.

<b>Nominal Diameter</b>	<b>Time required for producing bonding at construction site in minutes</b>
25	20
40	20
50	20
65	25
80	27
100	33
125	40
150	45
200	50
250	60
300	80
350	100
400	120
500	165
600	200
700	230
800	265
<b>Nominal Diameter</b>	<b>Time required for assembling pipes at construction site in minutes</b>
25	10
40	15
50	17
65	18
80	20
100	22
125	25
150	35
200	45
250	55
300	75
350	90
400	110
500	150
600	180
700	210
800	240

#### 4.2 Recommended maximum screw tightening torque for flange connection

<b>GRP collar / steel loose flange</b>		
against <u>non full</u> face gasket		
Gasket: Kroll und Ziller		G-St. Profile
ND	tightening torque [Nm]	Example
25 - 80	25	Collar / loose flange GRP  fix flange steel
100 - 150	50	
200 - 300	75	
350 - 400	100	
500 - 600	200	
700 - 900	300	
1000 - 1400	500	

<b>GRP collar / GF-UP loose flange or fixed flange</b>		
against <u>non full</u> face gasket		
Gasket: Kroll und Ziller		G-St. Profile
ND	tightening torque [Nm]	Example
25 - 50	17	Collar / loose flange steel  fix flange GRP
65 - 100	25	
125 - 150	30	
200 - 300	50	
350 - 400	75	
500 - 600	90	
700 - 900	100	
1000 - 1400	150	

<b>GRP fixed flange against full face gasket</b>		
against <u>full</u> face gasket		
ND	tightening torque [Nm]	Example
25 - 80	25	fix flange GRP  fix flange steel
100 - 150	50	
200 - 300	75	
350 - 400	100	
500 - 600	200	
700 - 900	300	
1000 - 1400	500	

**Increase tightening torque in steps of 15Nm!**  
**Tighten screws always crosswise!**