



Yangzhou XinYang Technology Development Co., Ltd

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Installation Manual For Key-Bonding and Key-Lock Pipe

Yangzhou Xinyang Technology Development Co., Ltd



Foreword

This manual introduces the installation procedures of the Key-Bonding and Key-Lock series of GRE pipe products of Xinyang Company, which varies with the installation of carbon steel pipelines, stainless steel pipelines, lined pipes and fiberglass pipes with different joining system. Learning and mastering the instructions in this manual will be helpful for the long-term stable operation of the installed piping system. All personnel involved in the pipeline construction must take the training held by the Xinyang Company.

This manual mainly includes the following sections: overview of the product, storage, transportation and installation preparation of pipeline, bonding of spigot and socket end between pipe and fittings, locking key joints between pipes, system maintenance and verification, installation issues to be considered, installation of buried Key-Bonding, Key-Lock pipeline and Appendix.

This manual introduces in detail the installation procedures and attentions for DN350-DN600 Key-Bonding , Key-Lock pipeline installation, including both the tapered spigot /socket joining and locking key joints. The spigot/sockets bonding joint are applied for Key-Bonding pipe series and fittings installation as well as repair of damaged pipes. As the locking key connection is different from that of bonding joint or threaded joint, the operators shall check carefully to ensure the completeness of installation equipments and spare parts and follow the instructions in this manual strictly.



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Safety Warning

Security warning signs shall be set at the installation and construction area to remind the staff of safety to prevent accidental injuries.

Since the pipeline may contain hazardous media or run under harmful pressure, the instructions in the manual must be complied with to avoid serious personal injury and property loss.

The installation personnel should learn by heart the instructions of the installation tools and adhesives and keep the operation surface clean, stable and well-ventilated.



Section I Overview

1.1 Pipe Products

The performance of GRE pipe products depends on its constituent, such as the variety of resin and curing agent, the manufacturing process, the thickness of inner corrosion resistance liner and the outer fire proofing jacket and so on. The pressure rating of Key-Bonding and Key-Lock piping system designed and manufactured by the Yangzhou Xinyang Technology Development Co., Ltd are ranged from 1.0MPa-5.0MPa, the temperature rating are 80°C and 120°C, the pipe size are ranged from DN350-DN600. In addition to chemical pipelines, both GRE piping system could also be used, in combination with filament-wound fittings, for salt water pipeline, fire pipeline and drinking water pipeline.

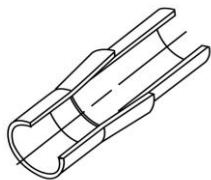
1.2 Fitting Products

The FRP fitting products matching with the Key-Bonding and Key-Lock pipe products are manufactured by filament winding process, and connected with the pipe by spigot /socket bonding joint.

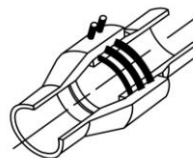


1.3 Joining System

The spigot/socket bonding joint is used for Key-Bonding series and locking key joint is used for Key-lock series.

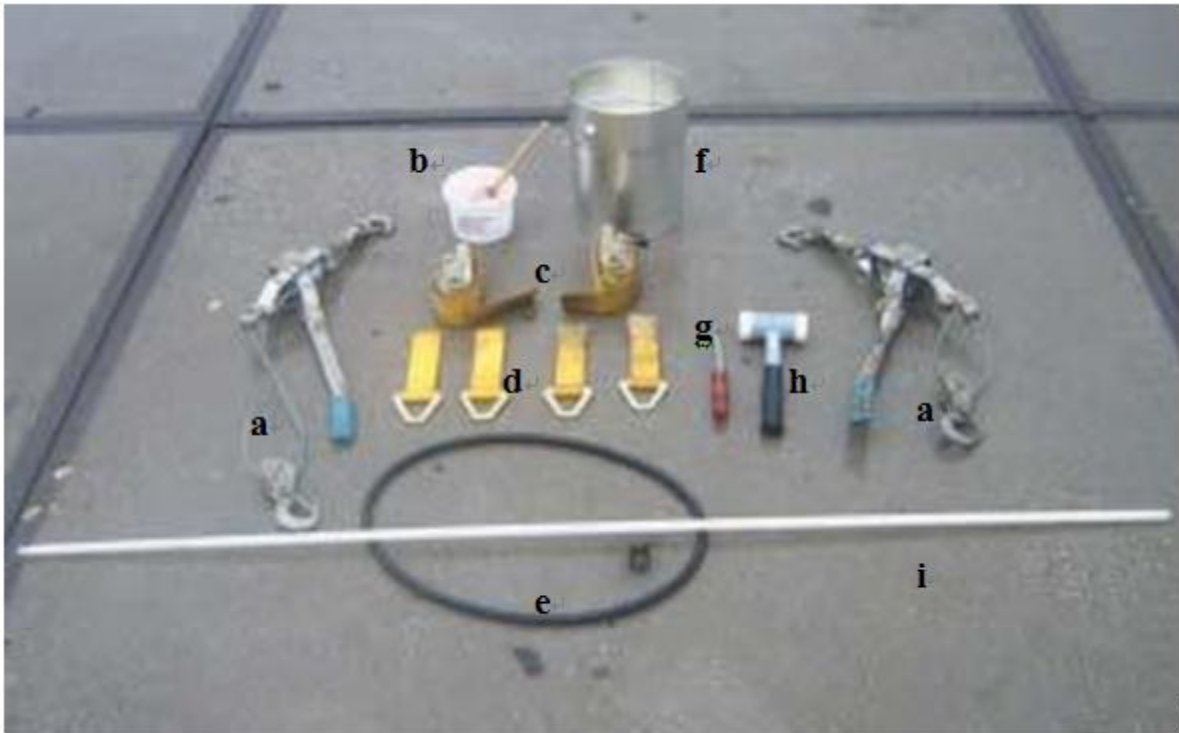


KEY-BONDING JOINT



KEY-LOCK JOINT

1.4 Auxiliary devices for field installation of **Key-Bonding and Key-lock series.**



The auxiliary devices in the figure above are respectively: a) winches (x 2), b) lubricant, c) strip (x 2), d) tension ring (x 4), e) O-Ring, f) bucket, g) screwdriver, h) hammer, i) locking key. Before installation, the operators shall ensure all these devices are available with super quality. All the devices may be provided by Xinyang, while the installation equipment, such as the crane, shall be decided by the contract side.

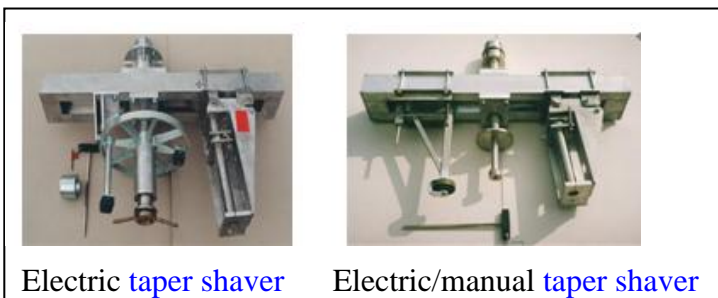
Electric heating blanket: The electric heat blanket provided by Xinyang Company is used for heating and curing of bonding joints during installation. The electric heating strip shall be used together with a voltage regulator to regulate the curing time of the joint.



Electric blower: The electric blower may be used to heat the bonding joint, with power not less than 1500 watts.



Field taper shaver



Electric taper shaver

Electric/manual taper shaver

The electric taper shaver is used for field taper preparation for DN350-DN600 pipes during installation, while the manual taper shaver is used for field taper preparation of pipes which OD is smaller than DN250.



Belt clamp



The belt clamps are used in combination with winches to connect bonding joint pipes and fittings.

1.5 Adhesive

Please refer to Table 1.1 and Table 1.2 for the parameters of adhesive.

The special adhesive for installation of Key-Bonding series is consisted of component A and B, which shall be mixed before use.

Table 1.1 Approximate amount of adhesive

Adhesive (Kit)	Pipe size				
	DN350	DN400	DN450	DN500	DN600
Number of joints	3	2	1.5	1	1

Table 1.2 Pot life of adhesive

The pot life is the period since the A and B gradients are mixed to the time of gelling.

Adhesive	Pot life /21℃ (minutes)	Storage period (years)
EP-305-1	18-25	1

Section II Storage, Transport and Installation Preparation

2.1 Storage and transport of pipes and fittings

The FRP pipes, fittings and adhesive require special storage and transport conditions. During the storage, handling and transport of Yangzhou Xinyang Key-Bonding ,Key-Lock series pipes products, special attention shall be paid to prevent impact or other form damages to the pipes and fittings. To avoid point load of pipes and fittings during transportation, wood boards with suitable width shall be used to separate pipes of different layers, so as to avoid impact and bending load of pipes. For pipes larger than DN350, at least 5 pieces of wood partitions shall be laid between pipe layers. For small sized pipes or loading height larger than 2m, the wood partitions shall be increased. The wood partitions shall be of a cross section of 100X30 with a spacing of 2.5m between each other, so as to achieve even load distribution. At both sides of the pipe piles, wood boards shall be used to fix the pipes and prevent pipe rolling. Attention shall be taken to avoid sharp or uneven hard surface contacting the pipes and damaging the pipe wall. When the Key-Bonding or Key-Lock pipes are directly placed on the field ground, stones shall be removed within the storage area.

The Key-Bonding or Key-Lock pipe ends of Xinyang Company has been packaged with soft protective material, which shall be removed right before installation, so as to avoid pollutants



or impurities getting into the tapered pipe ends. The FRP fittings are packaged in carton or wooden box and shall be stored in clean dry area. When the fittings are to be removed from the packages, attention shall be taken to avoid the grinded spigot/ sockets ends exposed directly in the sunlight.

The pipe wall structure maybe damaged by friction or impaction during transport , therefore, the pipe wall must be examined thoroughly before installation to avoid any serious mechanical damages.

Any damaged Key-Bonding and Key-Lock pipes shall not be used, unless they are examined and approved by the Yangzhou Xinyang Company. The pipe suffered from impact will show emission-like cracks at the damaged area, for pipes of this kind, the damaged segment shall be cut off from 300mm apart from each side of damaged section.

2.2 Tools, devices and spare parts required for pipe installation

To maximize the installation efficiency, tools and devices recommended by the Xinyang Company shall be applied for installation of Key-Bonding and Key-Lock pipes.

A. Necessary tools for DN350-DN600 pipe installation under normal conditions:

- 1: Chain vice. To prevent the pipe crushed by the chain, rubber sheet or FRP pipe tiles with the same diameters shall be applied at the contacting surface.
- 2: Height adjustable pipe bracket;
- 3: Pipe cutters (cutting saw with diamond blade);
- 4:40-120 grit sandpaper;
- 5: Tape-measure;
- 6: Markers;
- 7:3-6 pound hammer and 50X100 batten;
- 8: Manual /electric taper shaver;
- 9:12-16 pound sledgehammer and 100X100 batten;
- 10: Winches ;
- 11: Belt clamp;
- 12: Field electric grinding machine;
- 13: Electric portable drill with 30-60 grit grinding wheel;
- 14: Belt tension chuck (for saddle installation);
- 15: Lubricant;
- 16: Elastic O-Ring;



17: Nylon locking key;

18: Screwdriver;

19: Clean water

B: Auxiliary devices for installation at low temperature (below 21°C) :

1: Heat source such as electric blower or infrared light;

2: Adhesive insulation box (with temperature maintained at 21°C-26°C)

3: Electric heating blanket;

2.3 Adhesive installation at adverse climate

The Key-Bonding and Key-Lock pipeline of the Xinyang Company could be installed at all kinds of climate conditions as long as appropriate preventive measures are taken. While warm climate is most favorable for pipeline installation, the installation time at low temperature will be 20% -35% longer than that within factory.

A. Precautions for installation at high temperature

The pot life of adhesives will be greatly shortened at ambient temperature exceeding 32°C, thus the following recommendations shall be observed:

1: Avoid pipe joints directly exposed in the sunlight;

2: Store the adhesive in cool place;

3: Have the mixed adhesive preserved in sealed ice bath (or portable refrigerator);

B. Precautions for installation at low temperature

Low temperature will lengthen the curing time of adhesive, thus the following precautions shall be taken during pipe installation at low temperature:

1: Have the adhesives reserved at 27°C-32°C to accelerate curing of the mixture.

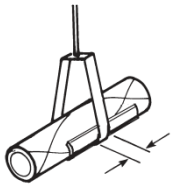
2: When the ambient temperature is lower than 21°C, have the connection surface preheated to 23°C-27°C.

3: When the ambient temperature is below 10°C, have the adhesive joints heated with electric heat strip and have the joints shielded with insulated iron box, so as to prevent heat diffusion.

C. Installation under high humidity

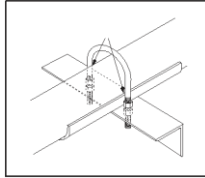
First of all, wipe the joint of pipe or fittings with a dry cloth or heat it with an electric dryer to remove the moisture. Then, have the adhesive surfaces thoroughly polished with sandpaper and remove the dust with a clean cotton cloth and finally have the adhesives evenly applied. Have the joints cured according to the curing requirement at high or low temperature.

2.4 Anchor block, guide and suport



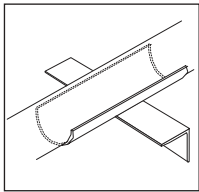
A. Pipe hanger

For overhead installation of Key-Bonding series fire pipes of Xinyang Company, pipe hangers shall be applied. But too many pipe hangers will degrade the pipeline stability and will cause vibration when the control valve is operated or the water pump is started or shut down. To improve the axial stability of the pipeline, have the pipe hangers used in combination with the guide groove.



B. Pipeline guides

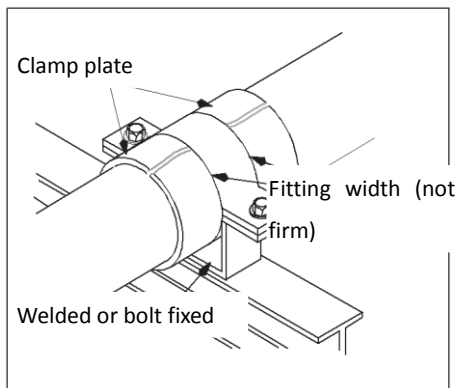
The pipeline guides are of rigid fixed structure to allow axial movement of the pipeline. Appropriate spacing of the guides is significant to ensure the movement of expansion joints and expansion rings and prevent pipe bending. The U-bolts of the pipe guides shall contact the pipe wall loosely to guarantee free axial movement of the pipeline. The pipe guides shall be installed at both sides of the joints between pipe and expansion joint or expansion ring.



C. Pipe supports

The purpose of pipe support is to avoid point load at the contact surface, but the application of pipe brackets does not mean that the pipe guides could be reduced. A half of the FRP coupling of the same size produced by the Xinyang Company is recommended as the pipe bracket. At locations of valve, water pump or heavy equipment along the pipeline, supports shall be installed.

D. Anchor block



The anchor block provides an independent expansion space for pipeline. Equipment connected to pipelines, such as the water pump, tank, are equivalent to anchor block. But for pipe connections with valves, bends, blind flange and branch, anchor blocks shall be added. Pipeline expansion shall also be considered for independent pipeline design. Only one expansion joint or expansion ring is allowed between two anchor blocks. The U-bolts of anchor blocks are not allowed to contact the FRP pipe wall.

2.5 Cutting pipe

When the Key-Bonding and Key-Lock pipes of Xinyang Company are required to be cut for fittings connection or repairing of damaged segment, an electric cutting saw with diamond blade is recommended to use.

1: Measure the length to be cut and calculate the insertion length between pipe and fittings.



2: Scribe the cutting line around the pipe and ensure the cutting section is vertical to the pipe axis.

3: Have the pipe fixed to avoid point compression load on the pipe wall. If chain vice or other mechanical clamps are used, attention shall be taken to avoid point load. Cut the pipe as smooth as possible and ensure the parallelism between the end surfaces not larger than 3mm after cutting.

2.6 Climate damage repair

For bonding connection, if the processed surface of pipes or fittings is exposed directly in the sunlight for over 4 hours, the following measures shall be taken to avoid to make an impact to the bonding strength of joints.

Remove the UV degradation layer on the spigot end with 80-120 grit sandpaper slightly, as too much grinding will change the taper of the spigot and socket ends and form void on the bonded surface. If UV degradation is serious, have the pipe ends cut of 25mm and re-grounded of taper. For exposed socket, 40-grit sandpaper is recommended to be used to manually re-grind the joint until new surface is seen; manual grinding must be slight to avoid changing taper angle of the socket.

Section III Installation for Key-Bonding Piping System

3.1 Precisely connected pipeline

The Key-Bonding pipes with spigot/socket bonding joint could be installed with precise length via special alignment. As the tapered surface of the spigot end is made by grinding process, any minor changes of the tolerance will affect the insertion depth of spigot. If the connecting length requirement at the pipe end is not too accurate, the impact of length change may not be considered. Otherwise, the length compensation could be considered. Have the spigot end re-grounded with a field grinding machine to realize precise connection length.

3.2 Calculation to achieve desired connection length

1: Check the distance from the center line to the end surface of the fitting (A) from the Key-Bonding FRP fitting manual of the Xinyang Company. Make a plug gage with 450mm long pipe segment and then grind it in accordance with the operation instructions of the grinding machine.

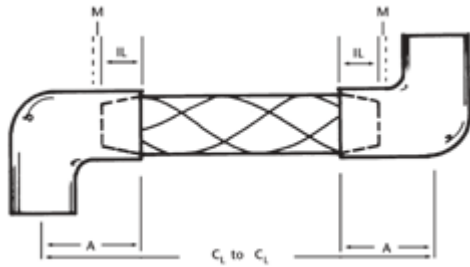
Check the dry insertion depth of the tapered segment of pipe, which shall be of the factory tapered spigot length ± 6 mm. Insert the tapered segment of pipe into the socket of fitting to get the dry insertion depth. Since the insertion depth of each fitting socket is different, the insertion depth of the sockets at both sides of fitting shall be measured with a standard plug gage made of a segment of FRP pipe. (Note: if the grinding machine is replaced or the set-up of the device is altered, a standard plug gage shall be remade).



As the adhesive is equivalent to lubricant, the insertion depth of pipe with adhesive shall be always larger than that at dry status, so an additional length of 5mm shall be added to the measured length (or basing on the field measurement)

Note: The additional length depends on the fitting of socket at dry status. If the size of the factory-made socket end is altered, the actual size measured at field installation shall be applied.

2: The cut length of pipe= $(C_L \text{ to } C_L) - (A+A) + (IL+IL) + (M+M)$, of which:



A = distance between the fitting centerline to the end surface

IL = dry insertion depth

M = additional length arisen at wet status

For flanges, take flange size A

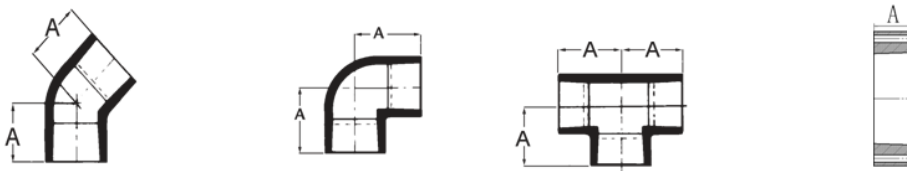
Use the centerline to centerline distance (CL to CL)

to realize precise pipe connection.

Notes: In case of a fitting of DN350-DN500 connected adjacent to other fitting by bonding process, it would be very difficult to be tensioned by use of winches, if they are not properly installed, voids will appear in the adhesion area. Hand lay-up is recommended to wrap the joint of fitting to ensure the tightness.

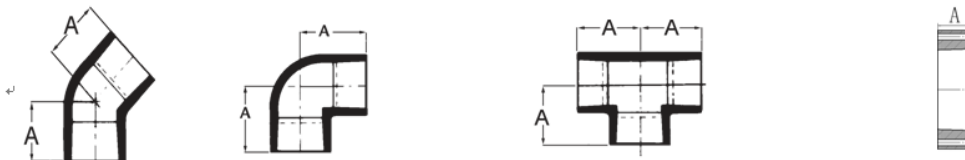
Table 3.1 Removal size of 1.0 MPa ~ 2.5MPa fitting

Note: The data in the table is used to measure the C_L to C_L length



(See products manual)

Table 3.2 Removal size of 2.5 MPa ~ 5.0MPa fitting



(See products manual)

3.3 Precautions for joint preparation

Grind the spigot end with the recommended shaver/grinding machine in this manual (set-up the parameter of the shaver in accordance with the instructions). If the socket of the fitting is exposed in the ambient environment for more than two hours, the inner surface of the socket shall be re-polished with 40-100 grit sandpaper and wiped of dust with cloth. If the ambient temperature is lower than 21 °C or the pipe or fitting is exposed in the low temperature too long, have the bonding surface preheated with an industrial blower or blowtorch before adhesion. The preheating temperature that the bare hand could withstand is favorable. The polished and cleaned bonding surface is not allowed to be heated with a blowtorch. If the bonding surface is touched with bare hands, have it slightly polished with sandpaper.

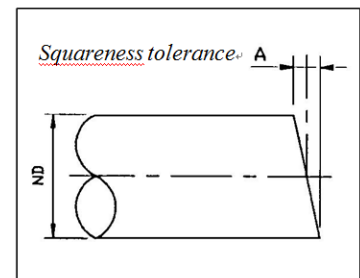
3.4 A The joint bonding process

1. Measure the required length
 - a. Scribe a line on the pipe with a ring template.
 - b. Fix the pipe with a vice grip and protect the pipe with rubber pad or similar device from damage.
 - c. Have the contaminated pipe wall cleaned before polishing of the pipe ends.
2. Pipe cutting
 - a. Use a hacksaw or a grinding wheel.
 - b. Ensure that the cut end is within the tolerance range listed in Table A.
 - c. These tolerances can be measured by keeping the collet end of shaver parallel and level with the cutting end of the pipe.

Table 3.3: Maximum squareness tolerance of the cut end

Range of pipe size		A
(mm)	(inch)	(mm)
350-400	14-16	3.0
400-600	16-24	5.0

3. Support and fix of pipe
 - a. Prevent pipe damage
4. Insert the collet into the pipe
 - a. Rotate the central tension bolt clockwise to fix the collet inside the pipe





5. Adjust the shaver/grinding machine to meet the pipe size

- a. Ensure correct taper angle
- b. Caution shall be taken during grinding of the first layer as the pipe wall may be uneven.

6. Grind the taper of the pipe.

- a. Keep maximum feed rate at 2mm.
- b. Grind repeatedly till required taper is processed.
- c. Considering the tolerance, sockets of nominal size is recommended to avoid too long or too short installation length. If the insertion depth is too small, the spigot end shall be grinded to match the socket.

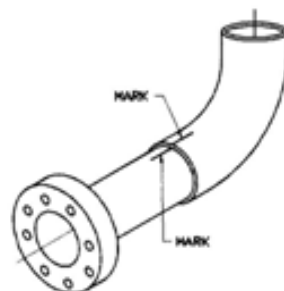
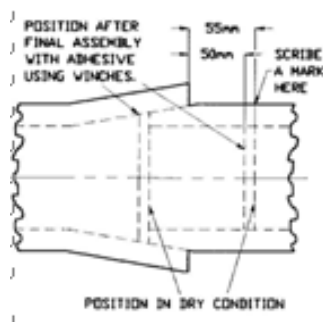
7. Have all the bonding surfaces grinded

- a. Have all the bonding surfaces grinded within 2 hours before the assembly
- b. Use a hand drill and a flap wheel or 60 grit sand cloth.
- c. The bonding surface shall be clean and dry before grinding, see step 10.
- d. The newly grinded surface shall not be too smooth.



8. Mark the joint.

- a. Check the installation length and mark the pipe and fitting to align the elbow and flange in a straight line.
- b. Measure from the spigot end and scribe a line at the insertion depth adding 50mm. After installation, pull the joints together with the scribed line 50mm from the socket end.
- c. During the final installation, the spigot may slide about 5mm into the socket, thus the joint



length at dry insertion shall be 5mm longer than the actual length.

9. Installation of winches

Install a belt clamp at both ends of the component and keep enough space for winches when pull the joints together. Two winches shall be used under normal conditions with additions when necessary.



10. Drying of bonding surface

- a. If the bonding surface is wet or has a relative humidity greater than 75%, it shall be dried.
- b. A blower or heating blanket shall be used.

11. Preheating or cooling of the bonding surface

- a. The recommended temperature of bonding surface is 15 °C - 40 °C.
- b. Heating blanket could be used to preheat the bonding surface.
- c. If the sunlight is too serious, the bonding surface shall be kept in the shade to avoid the temperature of the bonding surface exceeding 40 °C.



12. Re-polishing

- a. If the polished surface is contaminated or kept longer than 2 hours before installation, the surface shall be re-polished.

13. Cleaning of the polished surface

- a. Clean the dust with a dry cloth or brush.
- b. Never touch the polished or cleaned surface.

14. Mixing of EP-305-1 adhesive

If the adhesives storage temperature or the temperature of construction environment is lower than 21 °C, preheating is required before mixing with a temperature not exceeding 38°C. The operation instructions and notes of the adhesives are included in the package and shall be read in detail before application.

- 1: Pour the curing agent completely into the package of the resin material.
- 2: Have the curing agent mixed sufficiently with the resin material. If the resin material is sealed in an iron can, have the sealing lid cut to facilitate mixing with a wooden strip.
- 3: Have the adhesive mixed until the mixture is of uniform color and could flow continuously from the wooden strip. Scrap the bottom and walls of the can to ensure the mixture is even.

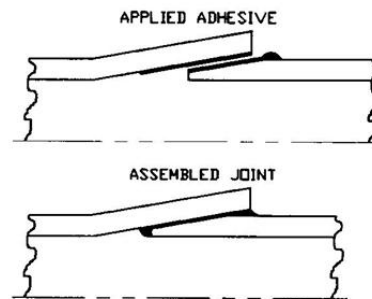
15. Applying of a thin layer adhesive

- a. Apply the adhesive with a spatula or scraper.
- b. All the adhesive surfaces (polished surfaces) must be completely covered with adhesives, with the adhesive thickness of socket about 0.5 mm and that of spigot about 1mm.
- c. Too thick adhesive will result in flow blockage.



d. Ensure the cylindrical surface of the spigot has sufficient adhesive to be covered by the socket.

16. Insert the spigot into the socket.



a. Have the spigot end inserted into the pipe socket to have the joint connected with attention paid to the scribed mark. If the spigot slips from the socket or rotates after insertion, connection failure may be resulted.

b. Hang two winches on the belt clamps and pull the spigot and socket together till the joint is fixed, the socket end shall be 50mm from the scribed line.

c. When necessary, wood partition shall be added between the winches chain and the pipe wall, so as to place the heating blanket.

d. The winches could only be removed after the adhesive is fully cured.



17. Remove excessive adhesive

a. Have the excessive adhesive, including that inside the flange, removed with a spatula.



18. Electrical heating blanket installation

a. Have the joints wrapped with electric heating plank of suitable size and ensure that the supply cable could be transferred through the electric heating blanket .

b. Ensure appropriate voltage.

c. Have the electric heating blanket installed according to the parameters in the table.

d. Insulation wires shall be used for electric heating blanket.

e. The sound contact of the electric heating blanket and pipe wall is significant for the curing of the adhesive.





f. If the temperature is lower than 10 °C or cold wind effect exists, the electric heating blanket shall be covered with insulation material, which shall be at least 100mm overlapped with the electric heating blanket and could cover the pipe, with the thermostat excluded.

g. Record the initial curing time, have the open pipe ends sealed during curing to avoid cooling with wind.

! Warning: Never touch the insulating material during the curing with electric heating blanket, otherwise, your skin may get burned.

3.5 Curing of spigot/socket joint of fittings

A. Curing at ambient temperature

The curing time means of the hardening period of the adhesive. The curing time of EP-305-1 at 15°C is 24 hours. If the ambient temperature is too high or too low, the adhesive curing time will be longer or shorter, thus the curing time could be shortened via heating. The maximum heating temperature for curing recommended by Xinyang Company is 150°C, because the cured adhesive joints at this temperature could achieve the best mechanical property and chemical resistance property.

B. High temperature heating blanket

Note: before having the bonding joints cured with electric heating blanket, the adhesive shall be gelled. The heating blanket is not allowed to be bent or folded with hand, so as to protect the elements from being damaged.

1. Heating of pipes and fittings

1) The size of the heating blanket shall match that of the pipe and heating blanket for large-diameter pipes shall not be used for small pipes.

2) Have the pipe joints wrapped with thermal conductive soft material and then carefully wrap the heating blanket outside the soft material and finally lock tightly the fixing belt of the heating blanket.

Warning: Never touch the insulating material during joint curing with electric heating blanket to prevent skin burns.

2. Heating of flanges:

1) To heat the flange with industrial blower, keep the exit of the blower at least 150mm from the end surface of the flange.

2) To heat DN350-DN600 flanges, the size of the heat strip shall be slightly smaller than that of the pipe and the belt of the heating blanket shall be removed.

3) Have the heating blanket rolled carefully into a cylinder and inserted into the inner surface of the flanged joint, then support inner diameter of the heating blanket with a short pipe section to make the outer diameter of heating blanket completely contact with the flange socket.



3. Heating of the saddle

For the bonding of saddle at low temperature, it is suggested to wrap the saddle outer surface with the heating blanket and have it shielded with an iron incubator with insulation layer. The curing time shall not be less than two hours. Before applying external force on the saddle, have its temperature reduced to ambient temperature.

Table 3.4 The curing time of EP-305-1 adhesive by use of heating blanket

Pipe size (mm)	Curing time (minutes)
350-450	60
450-600	120

The heating blanket can only be removed when the bonding joint is heated and cured as specified in the above table otherwise continue pipe installation or pressure test can not be carried out. The curing time in table above fits for the installation environment of 21°C-38°C, if the ambient temperature is below 21°C, the curing time shall be extended accordingly (Please refer to the installation requirements at low temperature). If appropriate heating source is not available, the curing time of adhesive joints at 21°C -38°C shall not be less than 24 hours.

The concentrated adhesives will be cured much faster than that in the joint. Therefore, before the adhesives in the joints are sufficiently cured, pressure test of the pipeline is not allowed.

Section IV Connection between Key-Lock Pipes

4.1 Installation of joints

1. Before installation of the Key-Lock series pipe, have the joint protector at the spigot/socket end removed. The protector is used to keep the cleanness of the joining surface and the groove of locking key so remove it just before installation.
2. Clean the socket or the fittings as well as the seal surface with a dry cloth and brush.
- 3 Clean the spigot end (locking key and O-ring) groove.
- 4 Apply a layer of lubricant to the grooves of O-ring and the locking key of the spigot.
5. Apply sufficient lubricant to the inner surface of the socket and the grooves of locking key. Have the positioned pipes rotated appropriately to keep the hole of locking key of socket at the position of 12 o' clock..



The lubricant shall be applied when the preparation work for installation is completed.

6. The lubricated surface shall be kept clean, and the joints and seal face shall be free with any impurities including sand or dust. The O-ring and joint surface shall be applied with appropriate lubricant, so as to avoid accidental cutting or slipping of O-ring during installation.

4.2 Placement of O-ring

- 1 Have the O-ring cleaned with water or clean cloth.
- 2 Check to ensure the O-ring is not damaged and is of the right size.
- 3 Have the entire surface of the O-ring lubricated and slide it into the first groove of the spigot end (O-ring groove).
- 4 Position the O-ring into groove smoothly with a screwdriver sliding under the O-ring around the joints. Special attention shall be taken to protect the O-ring from damage as a qualified O-ring plays a critical role for waterproof of the joint.

4.3 Insertion of the pipe

- 1 Align the spigot end and the socket end of the pipeline aligned in a straight line as proper alignment is critical for qualified connection.
- 2 Have the joints fully installed at aligned condition and then adjust connected pipeline to keep its direction same as the trench.
- 3 Turn the socket end of pipe or fitting to make the key hole at the location of 12 o'clock for easy insertion of locking key.
- 4 Place two belt clamps at both sides of the joint with one at the bell or behind the coupling, the other 1.5m (4.5 ft) from the spigot end.
Ensure that the tension ring is placed at three and nine o'clock position.
- 5 Winches are proposed to use.
Connect the Winches to the tension ring of belt clamp at both ends connected, then pull the pipes together.
6. Have the Winches strained at both sides to make the O-ring slide into

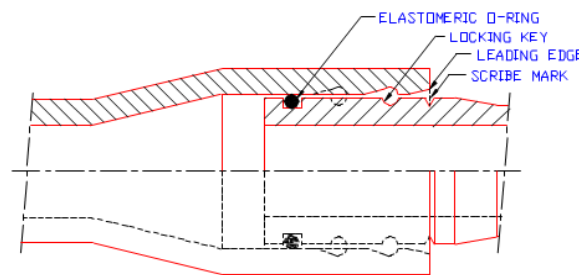


the groove smoothly without being squeezed out or slid off.

7 Have the spigot inserted into the socket until the scribed line is level to the bell surface. Rubber pads may be used below the belt clamp to avoid it sliding off. The belt clamp shall not be too tight to avoid collapse of pipe wall. Rubber pads or FRP saddles may be placed below the belt clamp to avoid collapse of the pipe wall. The saddles could be made with surplus pipe segments (cut into 90 °tiles).

The entrance shall be straight and smooth to facilitate installation.

8 Observe carefully to see if the entrance concentricity is uniform along the pipeline. When the scribe mark is 6mm from the end face of socket, have the locking key prepared and inserted.



4.4 Insertion of locking key

- 1 Check and ensure the locking key is not damaged and is of the right size.
- 2 Have the front end of the locking key lubricated before inserting it into the hole.
- 3 Have the lubricated locking key inserted into the hole and pull the pipes slowly together until the locking key slides into the groove of key. Check the alignment of the joint along the pipeline and observe the parallelism of the scribe mark with the end face of bell.
- 4 Have the locking key pressed into the groove of key with a hammer or mallet until suitable length is inserted.

Make a mark on the locking key at the circumference length of the pipe, with about 75mm-100mm of the locking key kept at the outside.

- 5 Have the winches and belt clamp removed after the locking key is installed.

4.5 Positioning and alignment of connected pipes

1 After the locking key is installed and the winches and belt clamp removed, rotate the joint to make it fit with the support or trench bottom. When the pipe is completely supported at the final position, have the hanging belt released.

Note: When the buried pipeline is installed at the bottom of trench, the hanging belt shall be placed at the pipe ends to facilitate straightening during installation of the next joint.

2 To prevent too much movement or bending of pipeline at the bends and branches during hydrostatic test, the pipelines shall be pulled forward with a winches or other means.



4.6 Cutting of pipes

Nipple of special length are often used for installation. To cut the pipe and prefabricate the pipe end in the factory, an adapter shall be connected to the new spigot by bonding process. If the double-male nipple prefabricated in the factory is applied, field cutting and bonding of the pipe could be omitted. The special tools, devices and installation instructions are provided by the representatives of the Xinyang Company.

4.7 Connection with other pipelines or equipment

The GRE pipe could be connected with other metal or thermoplastic pipe with ANSI-B16 150-pound drilling flange, or other flange drilled according to special orders. The filament-wound flanges (as the picture below) and RF flange shall be connected with a torque wrench and bolts. The flanges could be sealed soundly with lined steel structure. If the rubber gasket with thickness of 3mm and Shore hardness of 60-65 is used, the best effect will be achieved.

Highlights: to connect the GRE pipe with metal pipes, anchor block shall be installed next to the joint and at the side of the metal pipe, so as to avoid the expansion or contraction of the metal pipe transferred to the GRE pipe.

4.8 Installation of the saddle

Preparation before bonding

- A Have the bonding surface of saddle completely polished within 2 hours before the assembly.
- B Use a hand drill and a flap wheel (700 rpm - 2000rpm), or 60 grit sandcloth.
- C Keep the bonding surface dry and clean before polishing.
- D The polished surface shall be matt like, too smooth is not allowed.

Installation of the saddle

- a Scrape off a thin layer of adhesive (about 0.5 mm) from all the bonding surfaces (including the saddle and pipelines).
- b Have the saddle installed at the right position on the pipeline.
- c Have the saddle shoulders clamped with belt clamps.
- d Have the saddle wrapped with heating blanket of appropriate size and maintained at proper curing temperature. The curing time could be checked in the Adhesive Manual.



4.9 Highlights

This product manual and the recommendations in this manual are based on test data that are rational and reliable. This manual shall be limited to personnel specially trained under conventional industrial production and normal working conditions. The variation of application environment and operational procedures and extrapolation of data may generate unexpected consequence. We suggest the user-side engineers to verify the expected application of the product. Since we have no control of the work environment, we expressly deny any responsibility for the consequences or any indirect loss suffered by the user due to the application of the data in this manual.

4.10 Safety

The operators shall always wear protective clothing, gloves and goggles (Figure 16).



Section V Repair of the System

The Key-lock FRP pipe system of the Xinyang Company is easy to repair and repair of piping systems generally refers to cutting off of the damaged pipe section or fittings and replaced with new material.

Warning: before replacing the damaged pipeline, the operators must know clearly the chemical properties of the fluid inside the pipe to prevent personal injury, and appropriate protective measures shall be taken if necessary. The pressure rating and the adhesives used for the pipeline repair must be consistent with the original pipeline.

5.1 Check the underlying causes of failure of bonded joints

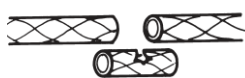
Joint back out - If the bead of the spigot is no longer contact the bell, the spigot will be backward before the adhesive cured.

Buckled Joint - If the joint buckled or misaligned, there will be a large gap at one side of the bell.

Improperly cured joint - if the adhesive at the edge of the joint is soft or bendable, the joint is not completely cured.

Weather damaged joint - if the grinded spigot surface turns yellow, the surface may be excessively exposed to UV. All damaged or improperly installed joints must be repaired or replaced in accordance with the following instructions.

5.2 Repair of severely damaged pipeline



If the diameter of the damaged area of the pipe wall is larger than 2.5cm, please have the pipe repaired with the following methods.



1: If the pipeline is partially damaged (less than 25mm along the length and greater than 5 mm around the circumference), check if the pipe system could be bent or moved, as two FRP coupling and a nipple might be needed for repair.



2: Cut off the damaged pipe segment, have the rich resin layer within 125mm of both side of left pipe end grinded off and prefabricated with a portable grinder or sandpaper of 40 grit or less (according to pipe size, either taper grinding machine or electric shaver shall be chosen), then install two hoops and one short pipe segment to repair the damaged area.

Note: This method is for pipelines with sufficient freedom to be raised or moved at both sides, so as to have the spigot and bell connected.

3: If both side of left pipe end cannot be fully moved and the repair coupling or nipple could not be installed, the electric/manual shaver shall be used to taper the pipe end and have the pipe connected with flange.

4: If the pipe end cannot be grinded on the pipe rack, a nipple could be connected by hand lay-up method.

1) Enough space shall be available at both sides and under the pipe to facilitate the operation. Cut off the damaged pipe segment and measure the distance between left pipe ends. Cut a new pipe segment with 3mm spacing between the new segment and both side of left pipe end.

2) Grind off the rich resin layer at both side of left pipe ends. Fix the new pipe segment between the left pipe ends and maintain straightness with the original pipeline. The pipe segments must be firmly fixed to avoid movement during pipe wrapping. Paste one 25X50 glass cloth with adhesives at the quarters around the pipeline circumference for positioning. (See the wrapping method in 4.3)

5.3 Repair of cracked joint and minor pipe damage

Wrapping - if the joint leaks at one location due to improper installation or the diameter of the damaged area is smaller than 50mm, the damages could be repaired by wrapping of resin and glass woven roving. The working environment temperature shall be of 24°C -32°C, and wrapping in the sunlight is prohibited.

1: Repair with 7-10 oz PPG woven roving or equivalent and the room temperature curing EP-305-2 repair adhesive.

2: Have the slope between the fitting shoulders to the pipe made level with thicken paste. The paste layer shall be as thin as possible because of its lower pressure loading capacity.

Note: the pipeline shall be empty with fluid and pressure when the above method is applied to repair the pipeline.

3: Have the surface re-polished and cleaned after the paste is cured.

4: Have the adhesive and curing agents sufficiently mixed with a wooden spatula till it appears uniform color and could flow smoothly from the spatula.

5: Apply the mixed adhesive to the polished surface with a clean brush.

6: The glass woven roving shall be cut with gradually increased length, with the short segment wrapping the inner layer and the longer segment wrapping the outer layers. The woven roving shall be overlapped at least 50mm during wrapping.



7: Lay a piece of woven roving at the middle of the joint and press the cloth till it is completely saturated with adhesive, then press out the air bubble wrapped in the lamination. During wrapping the joint, ensure the end edge of each piece of woven roving exceeding the initial edge, and air bubbles free in the lamination. As the wrapping operation, the wrapped woven roving will gradually lose their luster, which means that they are wet out by resin.

8: To avoid uneven thickness of the wrapped layer, the second piece of woven roving shall be wrapped starting from the end of the first piece.

9: To reduce the curing heat release of the wrapped layer, never have the woven roving wrapped continuously, have the first wrapped layers cured and cooled with a fan at first. Have the wrapped surface polished and cleaned with a grinding machine or sandpaper before wrapping of other layers.

10: Attention shall be paid to the bottom of the joint to avoid sagging.

11: When the ambient temperature exceeds 32°C, wrapping in the sunlight is prohibited.

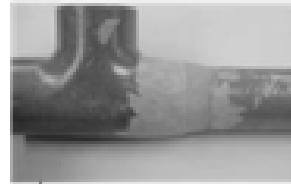
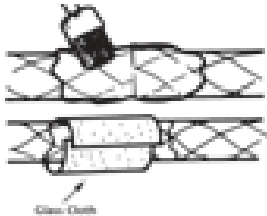


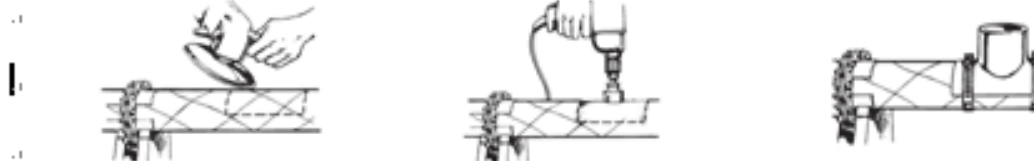
Table 9. Amount of wrapping resin for repair

Pipe size (mm)	Wrapping layers	Glass cloth width (mm)	Resin amount (kits)
350	14	200	6.5
400	16	200	8.0
450	18	300	9.5
500	20	300	11.0
600	22	350	13.0

5.4 Saddle and reducing tee

1: saddle – have the saddle placed on the pipe and marked around it.

(1) Have the resin layer of the bonding surface of pipe grinded off with a file, or a portable grinder or sandpaper (40 grit) (grinding with flexible grinding wheel is more favorable for large diameter pipes). The surface could be grinded either along the circumference or with random sequence.





5.5 Fire/UV coated pipe

- (1) Have the pipe grinded along the mark of the saddle with a sander and remove the fire/UV jacket with a screwdriver. Attention shall be paid to avoid damage of the pipe wall .
- (2) After the fire/UV jacket is removed, put the saddle on the pipe wall and mark the hole to be cut on the pipe. Have the hole cut with a pilot drill and a hole saw, with proper force to protect the hole edge being damaged.
- (3) Clean the bonding surface, if cleaning agents is used, the agents shall be completely evaporated before applying adhesive on the bonding surface.
- (4) Apply a thick layer of EP-305-1 adhesive to the outer surface of the pipe, the inner surface of the saddle and the edge of the hole.
- (5) Put the saddle on the pipe wall aligned to the hole and have both ends of the saddle clamped firmly with a belt/ steel tape clamp (both shoulder of the saddle shall be fit properly to avoid warping of saddle when the clamps are released). Have the clamps at both shoulder of the saddle tightened and straightened with two larger screwdrivers alternatively, till the adhesives overflows from the edge of the saddle, so as to ensure the sufficient contact between the inner diameter of the saddle and the outer diameter of the pipe. Remove the clamps at both shoulder after the adhesive is cured. Then have the saddle bonded at other locations with two clamps, if the first steel tape could not clamp firmly, have the second clamped first and add one more steel tape at the location of the first, then have the tapes tightened. Steel tapes of 12in² are recommended.
- (6) If coated pipes (with UV/ fire jacket) are to be repaired, have the jacket layer repaired with expansion coating layer as instructed in the former sections of this manual.

5.6 Deluge tee

If possible, install a normal coupling or a tee, a backup wrench shall be used to remove the testing plug or the nozzle, with torque not greater than 14 kg.m.

Section VI Notes for Installation

6.1 Recommended test

The instructions must be followed in order to prevent serious personal injury and property damage.

Hydrostatic testing

The hydrostatic test for Xinyang Key-Lock FRP pipe systems must be conducted before the system put into operation. Special attention shall be paid during the test to prevent the occurrence of water hammer.

Before hydrostatic test, all the anchor blocks, guide plates and brackets of the pipeline must be installed properly. When the test plug or the nozzles on the draining tee are to be



installed, stainless steel nuts shall be equipped as required with a torque of not more than 14 kg. M. The following rules must be observed during the hydrostatic test.

The water for hydro test is usually introduced into the pipeline by a DN25 pipe (or a larger size of pipe according to the size of pipeline) to eliminate air in piping system completely. The water inlet shall be at the lowest point of the pipeline with the exhaust valve or flange at the highest point. Close the valve slowly to raise the system pressure gradually. The test pressure shall not exceed 1.25 times of the lowest pressure rating of the fittings among the piping system. After the test, open the drain valve and get the water drained when the system pressure drops to atmospheric pressure again, so as to avoid vacuum collapse due to rapid water drainage of the piping system.

Notes: 1 Make sure the air within the system is thoroughly exhausted before the test. 2:

Warning: pressure test with air or other gas is not recommended. 3: it is strongly

recommended to conduct pressure test after installation of each segment of pipeline. 4:

Safety precautions: appropriate protective measures shall be taken for any system pressure test, so as to avoid risks of personal injury and property loss.

6.2 Startup and running of the system

For any pressure piping system, the initial startup must be carried out gradually to prevent damage to the pipeline or performance degradation due to overload or pressure fluctuations. One approach is to reduce the start speed of the pump and the opening speed of the exhaust valve, and an alternative is to start the centrifugal water pump against to a closed adjusting valve and then open the valve slowly.

6.3 Preventing of water hammer

Water hammer is a term used to describe the serious movement of pipeline when the pressure fluctuates, which is often caused by sudden shutoff of the valve, power off or other abnormal running factors. The pressure fluctuations will cause pipeline damages of different forms.

For FRP pipes installed above ground, water hammer usually occurs at the fittings due to the restraint of excessive pipeline movement because of the anchor block, guide plate and pipe supports. To solve this issue, installation of a retarder valve, a bypass pipe or a pressure fluctuation suppressor is proposed.

Gas in the pipeline system can also cause water hammer, so the air in the pipe system must be completely exhausted when the pipeline runs with full load. Sudden movement of the pipeline system will cause tremendous noise and instable running of the pipe system will result in water hammer.

6.4 FRP flange for the Key-Lock piping system

The Xinyang FRP flange complies with the 150 pounds 1"-24" steel flange requirements in the ANSI B16 standard, in the aspects of diameter, bolt hole number, bolt hole size and distribution. The size of the bolts shall be determined according to the requirement. The flat gasket shall be 3mm thick with the Shore hardness of 60-70.



Recommended bolt tightening sequence

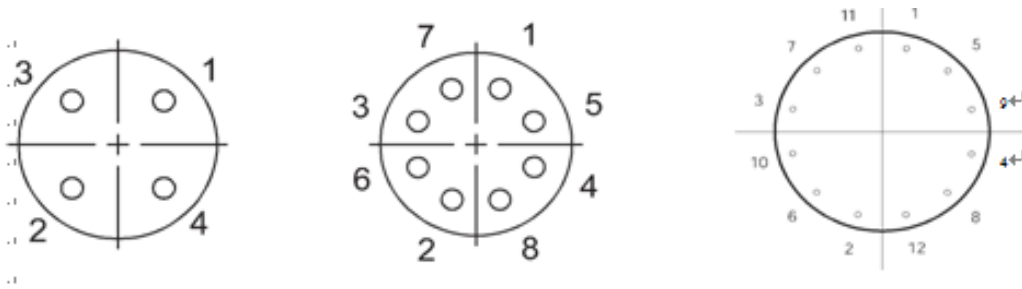
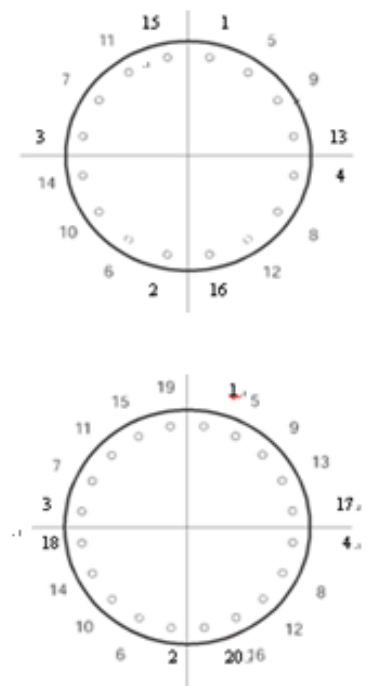


Table 10. Bolts and torque requirements

Nominal size of the pipeline (mm)	Number of bolts	Diameter of bolts (mm)	Maximum allowable torque (kg.m)
25	4	12	4.5
40	4	12	4.5
50	4	16	4.5
80	4	16	4.5
100	8	16	4.5
150	8	18	4.5
200	8	18	14
250	12	22	14
300	12	22	14
350	12	25	14
400	16	25	14
450	16	28	14
500	20	28	14
600	20	28	14



6.5 Connections with other piping systems

1: Adhesive of the Xinyang Company is not recommended to be used for bonding steel /metal pipes with FRP flange.

2: To connect the FRP pipe of Xinyang Company with steel pipeline or other FRP piping systems, flanged connection is recommended with the flange installed at the ends of the old pipeline and connected with the new piping system of Xinyang.

3: Before connection, have the anchor block, guide plate and support of the original pipeline carefully checked to prevent any stress or thermal expansion transmitting to the piping system of Xinyang Company.

4: Machining threads on the flange or pipe is not allowed.



6.6 Connecting to lug and wafer valve

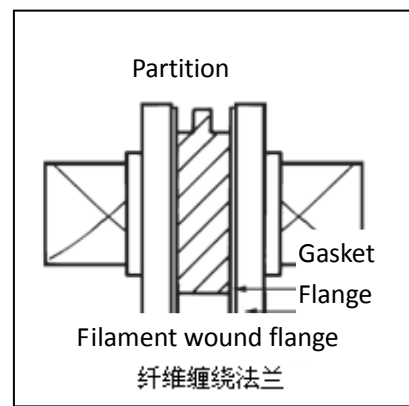
The sealing type of flat face are commonly used for lined valves of piping system. The parameters of sealing face of unlined valves could be found in the same valve manual. Sometimes, the groove at the valve sealing surface edge is too close to the pipeline inner diameter and does not match the sealing surface of the Xinyang FRP flange. When the Xinyang FRP pipeline is to be connected with non-flat face flange, the following recommended methods shall be followed.

1: For unlined, non-integrated sealed lug and wafer valve, gaskets 8.5mm thick and with Shore hardness of 60-70 shall be applied.

2: For integrated sealed or unlined lug and wafer valve, 0.6mm thick steel spacer with ID equal to Schedule 40 steel or conforming to the valve manufacturer's requirement, shall be used. Gaskets shall be installed between the steel spacer and FRP flange.

6.7 Connecting to pumps and other equipment

When the Xinyang FRP fire (Key-Bonding series) piping system are to be connected with pumps or moving equipment with vibration or shock load, flexible connections shall be applied with the flexible connectors for absorbing the shock and eliminating pipe and fitting deformation generated via stress. Rubber bellows type expansion joints are recommended to use.



6.8 Pipeline painting

Before painting, the pipe wall shall be clean and dry. The painted surface shall be completely polished by use of sandpaper or abrasive blasting (the fire or UV jacket is not allowed to be damaged). The Xinyang FRP pipe wall could be painted with all kinds of high quality epoxy paint, polyester paint, polyurethane paint, alkyd, or A, B components epoxy paint.

Section VII Installation of the Key-Bonding and Key-lock Buried Pipelines

7.1 Construction of trench

1. Trench size

Appropriate trench size shall be determined to provide a proper space for the pipeline installation, with the depth calculated in accordance with the bedding thickness of trench, the pipe height and backfill thickness. The trench shall be wide enough to accommodate the operator and the application of tools, pipe bedding at both sides and backfill. The trench width listed in Table 6.1 could ensure the pipeline installation.

2. Trench structure



1) Rocky condition

In case of trench preparation in rocky area, the width and depth of the trench must be ensured and a soil layer of at least 150mm thick shall be available between the pipe bottom and trench bedding.

2) Granular or loose soil

This kind soil is loose and easy to collapse under load. For trenches of this kind soil, wood board or diagonal support is commonly used to prevent collapse; otherwise, the trench shall be excavated with enough width to fill a large amount of bedding material at the pipe bottom or sides, to prevent excessive deformation of the pipe in lateral direction. Under some cases, the trench shall be deeper to allow more bedding material.

3) Unstable soil

In case of unstable soil condition, special measures shall be taken to provide stable environment for the FRP pipeline. Figure 6.1 is the recommended excavation process for areas with unstable soil.

Table 6.1 Width of common trenches

Pipe size (in)	Minimum width (mm)	Maximum width (mm)
2	460	660
3	460	685
4	460	710
6	510	760
8	580	810
10	640	860
12	710	910
14	790	960
16	840	1010
18	915	1060
20	990	1110
24	1120	1160

Table 6.2 Recommended base material and backfill material of the trench

Hardness ¹	Backfill material ^{2,5}	Compression degree ³ (%)
SC ₁	The sand content of crushed stone is ≤ 15%,	Dumped



	the maximum amount through the 9.5mm mesh is 25%, maximum content of fine sand is 5%	without compression
SC ₂	Coarse grained soil with sand content $\leq 12\%$	75-85
SC ₃	Coarse grained soil with sand content $\geq 12\%$	85-95
SC ₃	Fine grained soil with sand content $\leq 12\%$	85-95
SC ₄	Fine grained soil with sand content $\geq 12\%$	>95

- 1) AWWA M45 stiffness type
- 2) Maximum through-mesh rate of all soil is 25%
- 3) 1000psi stiffness after compressed
- 4) Small gravels can be used as a substitute
- 5) If abundant groundwater flow is foreseen, permanent trench shall be built.

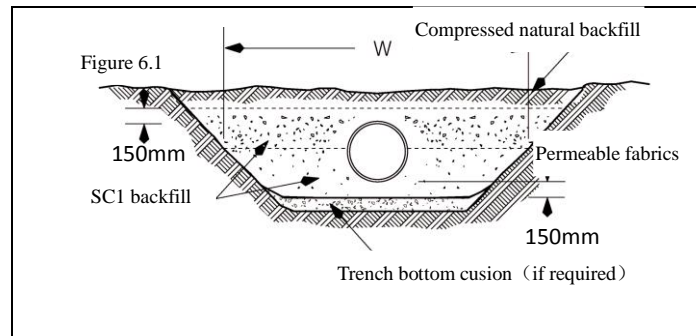


Figure 6.1 Pipe trench in area with soft unstable soil

3. Maximum buried depth

The maximum buried depth of trench is commonly not affected by the surface load, but is determined by the backfill soil modulus. When stable soil of 1000psi modulus is used as backfill, the largest backfill depth shall be usually 3660mm-6100mm, and the maximum allowable backfill depth for soil of 700psi modulus is 5200mm. The data above is the typical buried depth and Xinyang Company can provide design for buried depth according to practical application of the customer.

4. Crossing highway

In case of crossing highway, protection measures shall be taken to avoid impact to the FRP pipeline by passing vehicles and the road load. The buried depth of pipeline under stable road foundation shall be determined as per AWWA M45. For construction under instable road foundation or with small buried depth, concrete casing or steel casing shall be equipped to protect the pipeline, as shown in Figure 6.2.

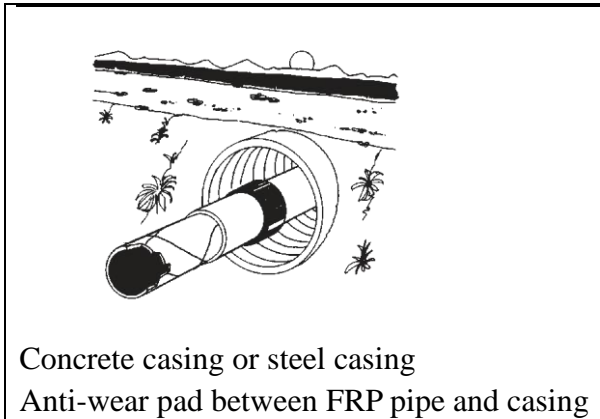


Figure 6.2 Typical highway crossing

7.2 Bedding and backfill

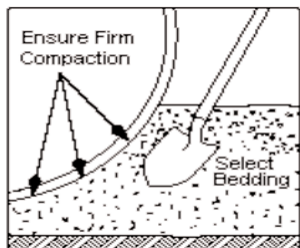


Figure 6.3 Proper bedding structure

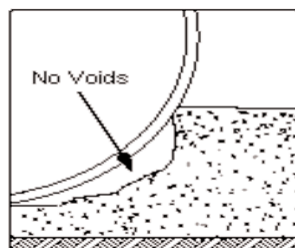


Figure 6.4 Improper bedding structure

1). Trench bottom

The trench bottom is the foundation supporting the piping system and appropriate bedding material must be equipped for flexible FRP pipeline. The bedding shall have a thickness of 1/4 of the pipe diameter and in full contacting with the pipe to provide continuous support. The proper/improper bedding structure is shown in figure 6.3 and 6.4.

2). Backfill material

To fill the bedding material at both sides of the pipeline, the thickness of each layer shall be 150mm and then compacted to required density, and the bedding under the pipe bottom shall be at least 150mm thick. The compaction of backfill material depends on the characteristics of material. Soil of high percent moisture or even with water flow is not recommended as the bedding. Xinyang Company recommends sand, gravel or crushed stone as the bedding material for FRP pipeline. If the native soil is among the recommended backfill material listed in Table 4.0, it may be used for bedding and backfill material, unless it has a high content of humus or frozen soil.

3) The top layer of the backfill

The top layer of the backfill shall be at least 150mm thick. The native soil can be used as the top layer of backfill, SC₅ unstable soil excluded (soil containing humus, organic material, frozen soil and ice, etc.). The top layer backfill material shall be compacted until it reaches the 1000psi modulus specified in Table 6.0. If the dump height of a scraper bucket is greater than 460mm, the thickness of each layer dumped backfill soil shall be controlled within 300mm. Have the backfill soil compacted layer by layer to the specified modulus, the thickness of each layer backfill material shall not exceed the capacity of compaction equipment. Before the pipe trench is backfilled and compacted, heavy equipment is not allowed to traverse across the trench.



7.3. Pipe connection and place-into trench

Xinyang Key-Bonding and Key-Lock FRP pipe can be connected one by one before placed into the trench. The elbows, tees and other FRP fittings shall be connected in the trench. To place the pipe into trench, hanging belt and lifting hook shall be used with the pipe bending degree not greater than the minimum bending radius of pipe. Complex underground piping system requires hydrostatic pressure test segment by segment. The piping system with hydrostatic pressure test qualified can be backfilled step by step as required above.

Appendix: Unit conversion and terminology

	Metric unit	British unit (U.S)
Length	1mm.....	0.03937in
	1cm.....	0.3937in
	1m.....	39.37in
	1km.....	1093.61 yard
Area	1mm ²	0.00155in ²
	1cm ²	0.155in ²
	1m ²	10.764 in ²
	1km ²	0.3861 miles ²
Volume	1mm ³	0.000061in ³
	1cm ³	0.061in ³
	1L.....	61.025in ³
	1m ³	36.314 ft ³
Capacity (fluid)	1mm ³	0.0338 ounces
	1L.....	2.1134 pints
	1L.....	1.0567 quarts
	1L.....	0.2642 gallons
Weight	1g.....	0.03527 ounces
	1kg.....	2.2046 pints
Pressure	1kg/m.....	7.233 pound.ft
	1MPa.....	145.04 psi
	1N/mm ²	10 bar
		U.S unit system metric unit
Length	1in.....	25.4mm
	1 ft.....	0.3048m
	1 yard.....	0.9144m
	1 mile.....	1.6093km
Area	1in ²	645.16mm ²
	1 yard ²	0.8361m ²
	1 mile ²	2.59km ²
Volume	1 in ³	16,387.2mm ³
	1 ft ³	0.02832m ³
	1 yard ³	0.7646 m ³
Capacity	1 ounce.....	29.573mm ³

Terminology

Adapter: special fitting used to connect pipe segments or fittings which with different type of joint.

Adhesive: Corrosion resistant material with high bonding strength and specified component ration.

Spigot/Socket joint: Joints with taper longitudinal section.

Sleeve: fitting with reduced diameter at the female end, with threaded or bonding joint.

Compression: a pair of relative force on the material, the circular compression will easily collapse the pipeline. The circular compression of FRP pipe comes from the end load generated from thermal expansion.

Molding: The molding technique of putting the prepreg into a closed mold cavity with specific configuration to form required product by adding pressure and heat curing.

Concentric reducer: The fitting to connect two pipe segments with different diameters and keep coaxial of the pipes.

Contact molding: FRP fitting molding technique of placing the reinforcing material in the mold to make it saturated with resin and cured.



	1 pint.....	1.47317L
	1 quart.....	0.94633L
	1 gallon.....	3.78533L
Weight	1 grain.....	.0648g
	1 ounce.....	.28.35g
	1 pound.....	0.4536kg
Pressure	1 in. pound.....	0.13826kg/m
	1psi.....	0.006894MPa

Coupling: thick-walled fitting with bell at both ends to connect pipes of the same diameter, the bell could be tapered, threaded or mechanical connected.

Curing: The process to make the thermosetting resin hardened via chemical reaction by heating.

Curing stage: the three curing stages of thermosetting resin, namely, A stage –flowing- B stage – gelling -C stage - fully cured.

Curing time: The time required for the thermosetting resin to be hardened by chemical reaction till maximum intensity is achieved,

depending on the temperature and the nature of the material.

Curing agent: The chemical agent mixed with thermosetting resin to make the resin molecular chain interconnected with each other.

Epoxy resin: Thermosetting resin containing epoxy group in the molecular structure.

Scarfed fitting: have the cut pipe segments with required configuration and have the joints reinforced via hand lay-up or filament wound to form a fitting, which is called Scarfed fitting .

Filament wound: The manufacture process for FRP pipe and fitting which is winding the glass roving on mandrel to form the product according to the specified winding pattern . The glass content and pattern could be precisely controlled.

Filler: the dispersant, pigment, inert additives, quartz sand, etc.

Fitting type: the fitting types classified according to the manufacture process, such as the molded fitting, scarfed fitting , winding fitting and hand lay-up fitting, etc.

Gel time: the time required from the resin begins to react till it shows the rubber elastic state.

Pipe guide: The device allowing the free movement of pipe along the axial direction, with the constraint lagging behind the movement of pipeline.

Hardener: the joint name for accelerator, catalyst and curing agent, used to accelerate the reaction and final hardening of the resin.

Heating blanket: the electrical device wrapping around the pipe and fitting to provide heat and shorten the curing time.

Hydrostatic test: the test with water at required pressure for the pipeline upon the completion of installation, leakage shall be checked at the joints and pipe body.

Impact resistance: the capacity of absorbing the impact energy without damages to the pipe.



Connection: the measures of connecting two pipe segments, including spigot/socket, threaded coupling or mechanical connections of different ways.

Joint: the connecting section of fixed-length pipe, in the form of spigot/socket bonding joint, threaded joint or coupling joint etc.

Liner: the resin-rich layer of 0.5mm-1.5mm thick in the pipe inner wall, the reinforcing material is usually polyester veil or glass mat. The liner could realize super chemical resistance and cracking resistance of the pipe.

Locking: having the fitting surface between spigot and socket contacted tightly to avoid rotation.

Matrix: the material bonding the reinforced material or filler together, it could be either thermoplastic resin or thermosetting resin.

Mechanical power: the power imposed to make the spigot/socket joint tightly fitted during pipe installation.

Polyester resin: the thermosetting resins with styrene as the coupling agent, of which the vinyl resin is a special polyester resin. The polyester resin is usually divided of o-benzene type and m-benzene type, with application depending on the performance requirement of the pipes.

Pot life: the period suitable for operation after the thermosetting resins or adhesives are mixed with curing agent.

Pressure rating: the maximum long-term work pressure of the pipeline specified by the manufacturers, refer to the working pressure, pressure rating, and design pressure.

Reinforcement: the fiberglass, carbon fiber and synthetic fiber, etc., that enhances the strength and hardness of the composite. The performance of fiber plays a leading role in affecting the mechanical properties of composite. The fiber reinforcement mainly include:

- 1: Chopped fiber: 3-5mm long short fibers that are cut from continuous fiberglass.
- 2: Chop strand mat: the sheet material composed of short fiberglass (or other fiber) arranged randomly and bonded by the adhesives.
- 3: Surface mat: the porous sheet material made of fiberglass or synthetic fiber and used for the liners of pipes or fittings.
- 4: Yarn: the fiber product made of one strand or strands of fibers and used for filament winding process.
- 5: Yield: the yardage of per pound of fiber.

Saddle: the fitting bonding to the pipe wall to form branch.

Shelf life: the material storage time till failure.

Straight spigot/socket joint: a type of joint of which the spigot end is taper-free and the socket is designed with a stop edge.



Partition: the wood placed between pipe layers of the pipe stack, to avoid point load to the pipe.

Stress: the force acted on the unit cross section area of the material, with the unit of psi or MPa, which is different from the hydrostatic pressure unit psig.

Support span: the recommended maximum distance between two adjacent pipe supports.

Surge pressure: instantaneous pressure fluctuations which are usually caused by water hammer.

Thermal conductivity: heat transfer from the high-temperature surface to the low-temperature surface within the pipe.

Thermal expansion: the material (pipe) size change caused by temperature rise, and material (pipe) contraction will be led by temperature dropping.

Thermosetting resin: the insoluble and infusible resin system that is formed and cured through heating the resin or adding chemicals to the resin. The typical thermosetting resins are vinyl resin, epoxy resin, phenolic resin and unsaturated polyester resin, etc.

Impact : the force generated via the flow direction changing of the liquid column within the pipeline, as well as the axial end load generated at the fitting and valve due to static pressure.

Torque: the rotation torque forcing the pipe to rotate, equaling to the force multiplying the distance from the force origin to the rotation axis.