



ERECTION/ASSEMBLY INSTRUCTIONS HOPPER BOTTOM SILOS



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Safety Guidelines

It is the responsibility of the erectors/owners of the site to ensure that all safety standards are adhered to and within the law of the specific site / country that the work is taking place.

Site work and conditions can be hazardous. Relevant procedures should be in place to ensure safety at all times.

Alterations to any of the supplied equipment **MUST NOT BE MADE** without the prior consent of the manufacturer, any alterations that are made without this consent may invalidate any warranty.

Ensure you know the locations of any service cables, drains, overhead cables etc. and relevant procedures are taken to avoid them.

Use of erection / assembly equipment, cranes, telehandlers, man lifts, etc. must be used in accordance with the suppliers instructions. Only suitably qualified personnel should be used to operate this type of equipment.

Be aware of other activities on site.

Keep the site tidy and free from packaging and general waste, all of which can cause trip hazards.

Construction sites will have channels, ducts, vent holes etc. especially in and around the silo base, these should be covered or guarded where necessary to prevent injury.

Information contained within this manual must be read and understood and retained for future reference.

Safety definitions



TAKE NOTE. This indicates an extremely hazardous situation which to be avoided at all times.



Potentially hazardous situation which if not avoided could result in an extremely hazardous situation.



If ignored could cause injury.



This symbol indicates a general hazard be aware.



This symbol indicates a prohibited activity.

Safety precautions

When on site erecting or visiting PPE should be used at all times, in accordance with site regulations and relevant health and safety laws.



Follow safety instructions

Each operative should read and fully understand all safety measures in this manual.

Safety signs need to be in place and kept in a good visual manner, additional safety decals can be obtained from the manufacturer.



Do not operate any machinery if instruction has not been given or you do not fully understand the equipment.



Understand before any maintenance procedures the requirements of the particular machine.

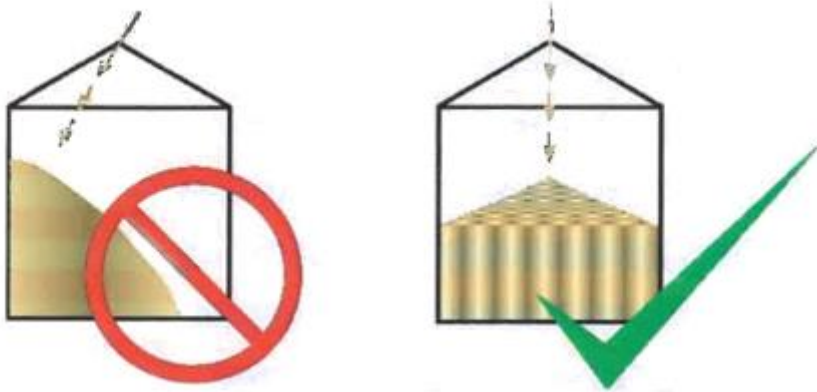


Never clean, service, remove parts of any machine whilst it is in operation.

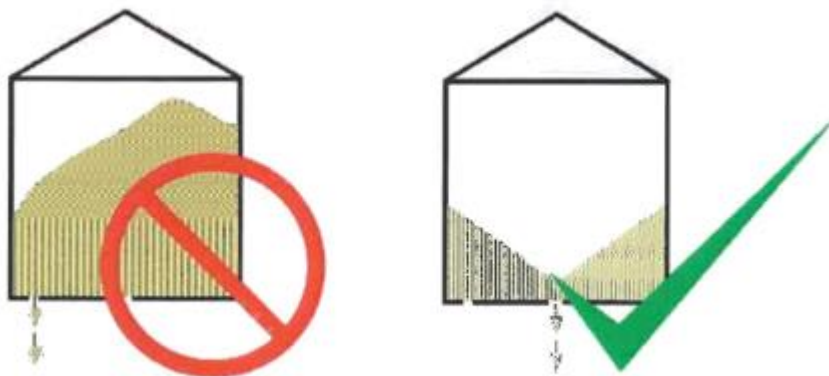
Unloading and Loading the silo



Round silos are designed to be loaded and unloaded centrally so all horizontal hoop stresses and vertical loads are evenly distributed around the silo.



When loading and unloading ensure there is adequate venting, so air can displace freely and avoid any damage due to suction or blowing.



Never use side discharge auxiliary openings to discharge this will cause extreme variances in pressures around the silo and possible collapse.

Only discharge through the central opening. Until there is no more product above this opening. Safety protocols need to be in place to ensure this happens.

Unloading and Loading the silo: continued



The grain level must never pass the eaves of the silo, protocols must be in place to ensure this does not happen,

Hi level indicators should be in place to signal stop filling, remember there will be grain in transit from elevators and conveyors which will need to be catered for when positioning the Hi level indicators.

Over filling the silo will cause blockage of the roof vents and if aeration fans are blowing or sucking it will cause over pressure within the silo resulting in possible damage.



Materials to be stored



This silo has been specifically designed for a free flowing product at a specific density, angle of repose, friction factors etc.

Do not assume that this silo is suitable for any free flowing product as all products have differing properties. Some which have lighter densities may have higher angles of repose or higher Wall friction factors.

Any doubt consults the manufacturer.

Storage of components



Your silo components will be delivered from Bentall's factory in good condition ready for site assembly.

If your intention is to store the goods before erection takes place ensure they are stored under cover preferably in a clean, dry area away from any sources of chemical pollution.

Hot dipped zinc coated steel has a life of many years when freely exposed to the air, however if moisture is trapped between sheets in a stack then the zinc coating can deteriorate and water staining (white rust) may occur.

Condensation due to rapid changes in temperature must be avoided and storage therefore should be at a n even temperature above the dew point.

Always store the goods on wooden pallets or metal skids so the packs are not in direct contact with the ground.

Ideally sheets for long term storage should be split apart to allow air to circulate.

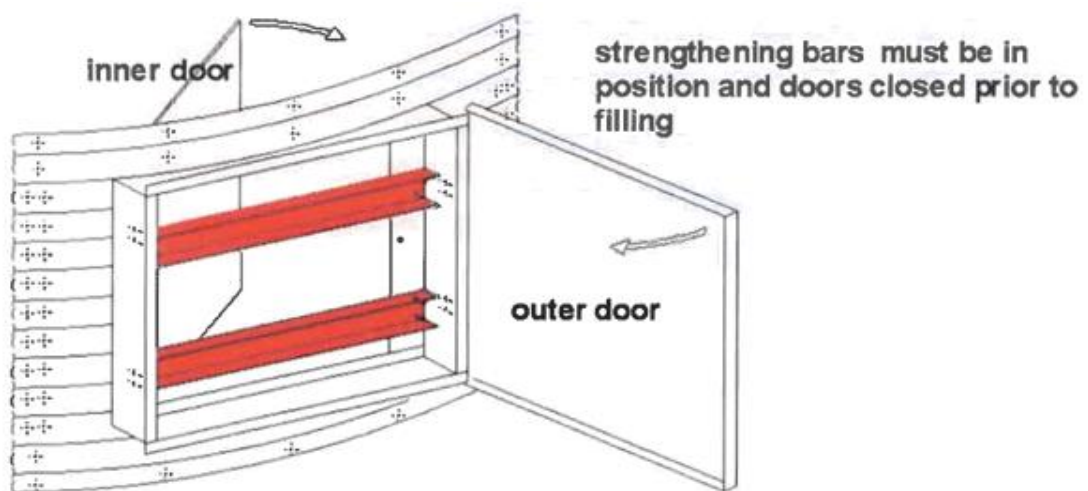
Doors



Silo doors have an inner door (opens inwards) and an outer door (opens outwards) **DO NOT ASSUME** that the inner door is closed and secured if the outer door is closed shut.

Protocols must be in place to ensure that the doors are closed and that strengthening bars are in place prior to any filling of the silo.

Filling the silo with a door open will effectively mean side discharging the silo resulting in uneven load distribution around the silo and could potentially be a hazardous situation.



If you have to enter the silo use extreme caution, isolate all filling, discharge equipment, fans, etc. Rescue procedures should be in place, breathing apparatus may be required, use a look out, outside the silo.

Decals

Safety decals are important and must be displayed and clearly visible, kept in a good visual condition at all times. Replacement decals can be obtained from Bentall Rowlands.

Aeration System:

Location: next to the fan

Size: 200mm x 130mm

Designation: CAUTION



DECAL No. BRSS H001

Access:

Location: On the hopper door

Size: 200mm x 130mm

Designation: DANGER



DECAL No. BRSS H002

Decals: continued

Safety decals are important and must be displayed and clearly visible, kept in a good visual condition at all times. Replacement decals can be obtained from Bentall Rowlands.

Door:

Location: On the outer door

Size: 200mm x 130mm

Designation: DANGER



DECAL No. BRSS 003

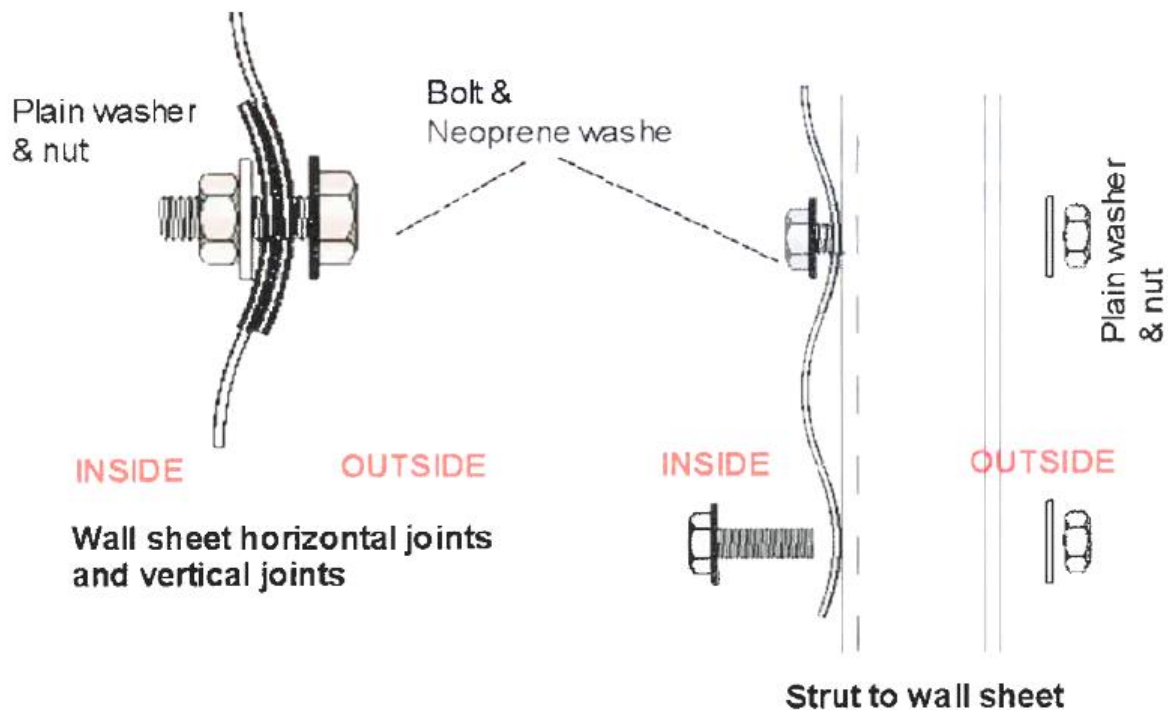


Bolts

Bentall Rowlands supply M10 and M12 bolts for wall sheets and struts these are grade 8.8 DO NOT SUBSTITUTE any other bolts, use only those supplied by Bentall Rowlands.

Torque settings for bolts, it is important to remember that an over tightened bolt can be as dangerous as one that is not tightened enough.

Bolt size	Minimum Torque		Maximum Torque	
	N-M	ft./lbs.	N-M	ft./lbs.
M10	20	15	25	19
M12	35	26	40	30



Bolts are supplied in various lengths, their position is dependent upon sheet and strut thicknesses, see your specific silo build up and bolt location for positions.

Wall sheets

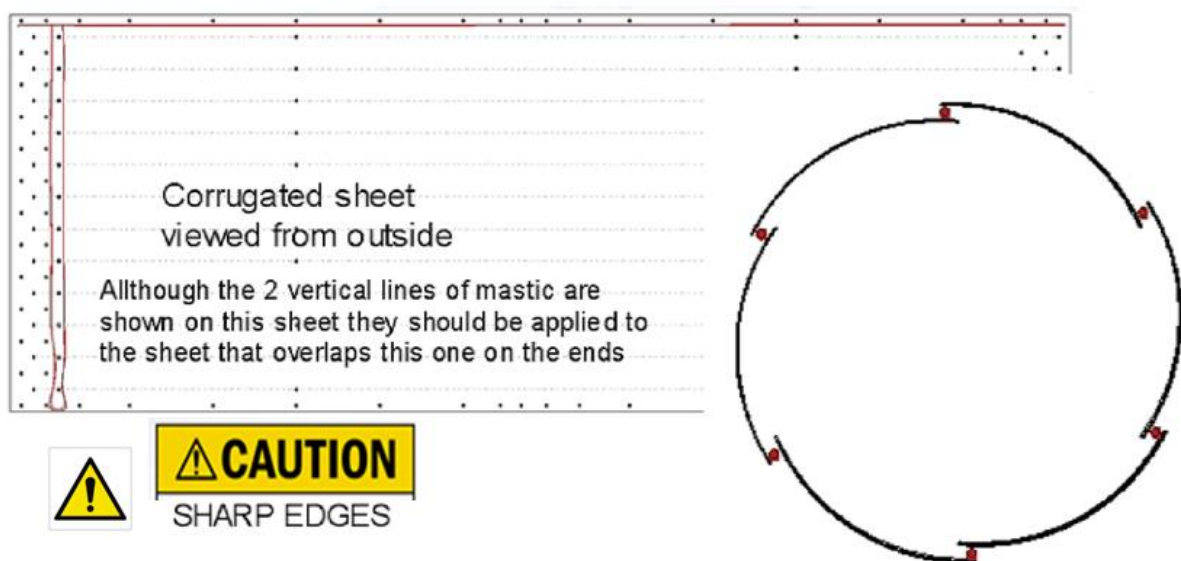
Mastic should be applied to the wall sheets as shown, 2 lines either side of the last vertical row of holes and along the top edge, just below the row of horizontal holes.

Assemble the ring of sheets (top ring) ensuring that the sheets are all overlapped the same way.

Use the correct size of bolt (see your individual sheet and strut build up and bolt location document) bolt head and neoprene washer outside, nut and plain washer inside.

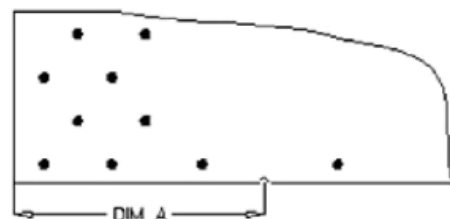
DO NOT TIGHTEN any bolts until all sheets are assembled and all bolts are in place.

Ensure when building additional rings of sheet, the correct thickness sheets are used, it is potentially dangerous to use the incorrect gauge.



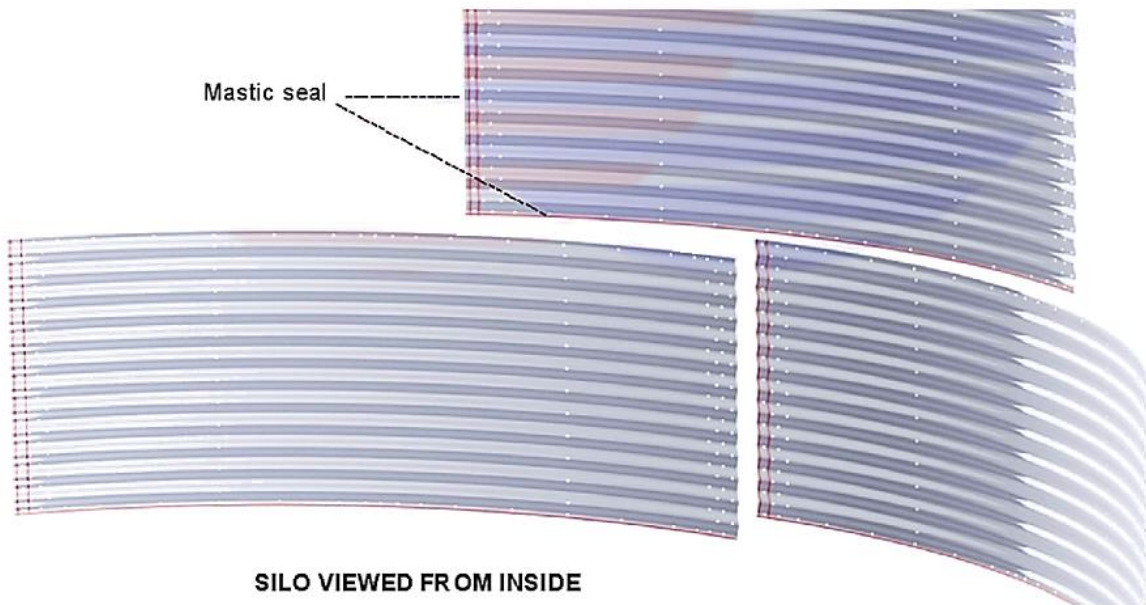
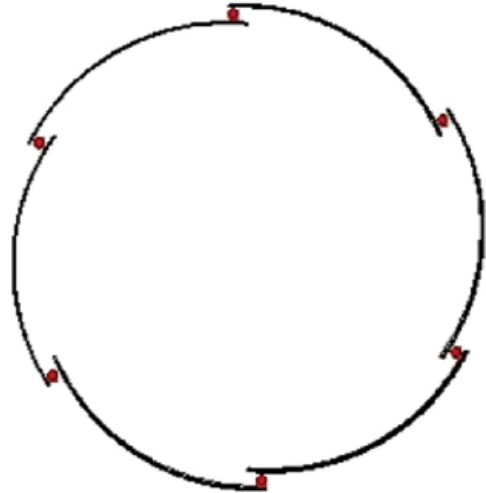
Sheet identification: there is a small notch on the bottom edge of the wall sheet.

Dim A :-	100mm	=	1.0mm sheet	32.71kg
Dim A :-	130mm	=	1.3mm sheet	42.52kg
Dim A :-	160mm	=	1.6mm sheet	52.33kg
Dim A :-	180mm	=	1.8mm sheet	58.87kg
Dim A :-	200mm	=	2.0mm sheet	65.41kg
Dim A :-	230mm	=	2.3mm sheet	75.22kg
Dim A :-	250mm	=	2.5mm sheet	81.76kg
Dim A :-	280mm	=	2.8mm sheet	91.57kg



Wall sheets: Continued

Because of the way in which silo's are built it will be easier to apply the horizontal mastic joint seal on the bottom of the wall sheet that is up in the air on jacks as opposed to on the outside top of the bottom sheet.

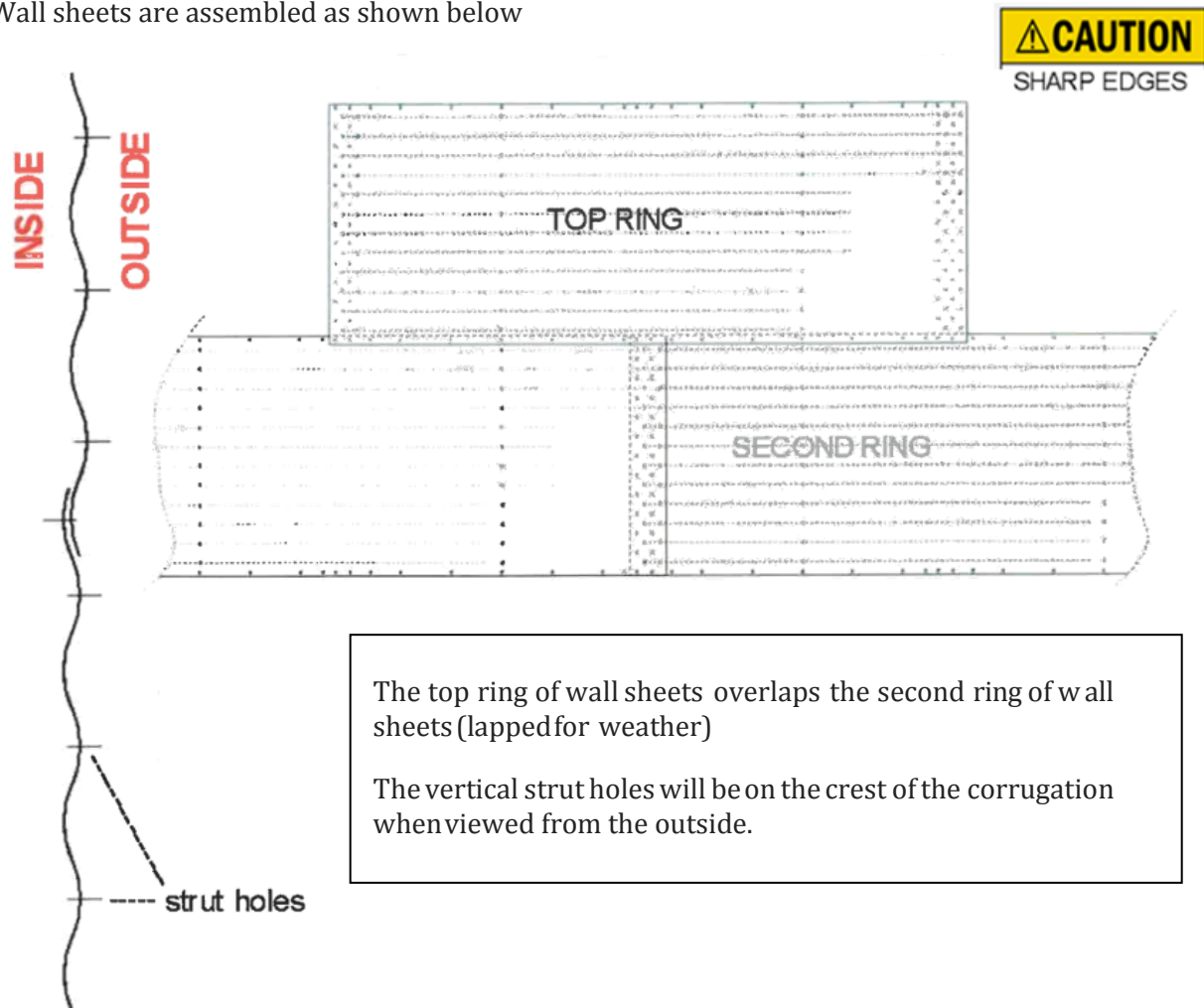


CAUTION
SHARP EDGES

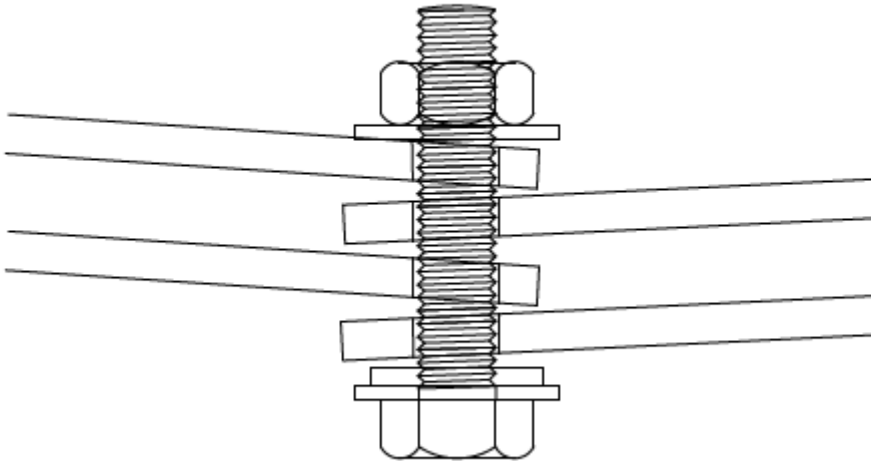
Wall sheets: Continued

To avoid misalignment of holes it is necessary to ensure all corrugated sheets are assembled the same way up, the identification notch should always be on the bottom edge.

Wall sheets are assembled as shown below



No. of sheets per ring	No. of strut runs
3.0m Dia - 3 sheets	6
4.0m Dia - 4 sheets	8
5.0m Dia - 5 sheets	10
6.0m Dia - 6 sheets	12
7.0m Dia - 7 sheets	14
8.0m Dia - 8 sheets	16
9.0m Dia - 9 sheets	18



Configuration of the silo wall sheet joint when two sheets are required

Struts



Strut identification:

Top strut: No flange holes in one end (no joint required) No. of holes in web 12

Overall length 1056mm.

intermediate strut (short): Flange holes top and bottom, No. of holes in web 12

Overall length 1174mm.

intermediate strut (Long): Flange holes top and bottom, No. of holes in web 24

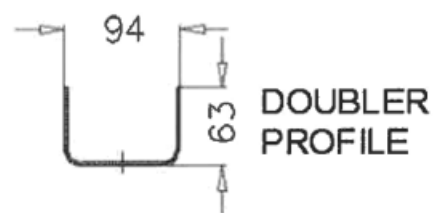
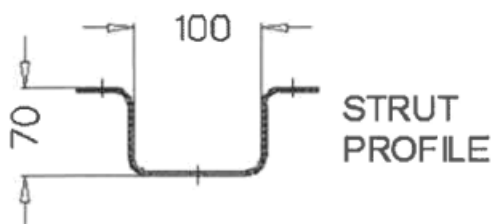
Overall length 2359mm.

Base strut (short): Flange holes top only, No. of holes in web 12

Overall length 1303mm.

Base strut (Long): Flange holes top only, No. of holes in web 24

Overall length 2488mm.



When the vertical loads on the struts dictates there is an insert added inside the strut profile, it is the same length and No. of holes as the strut it fits into, these are manufactured in 4mm, 5mm, and 6mm.

See your individual silo strut and sheet build up for positions of different thicknesses of struts and doubler struts.

Barrel assembly strut joints

TYPE A: Standard strut joints

1.6 mm to 6.0 mm struts

Joint strap x 1

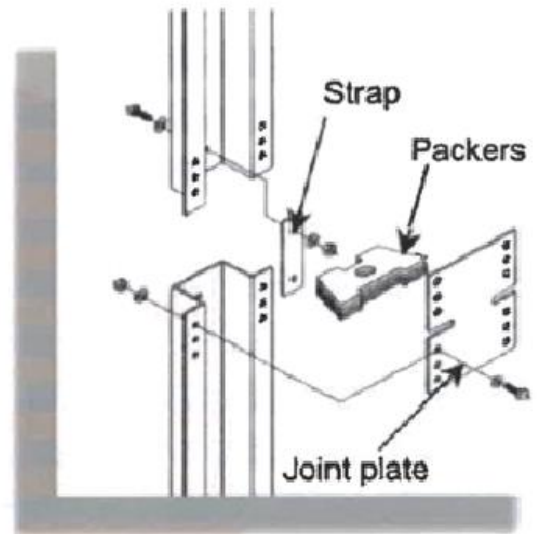
Packers 5mmx2

Packers 1mmx2+

Joint plate x 1

Strut to wall use M10x25 hex sets neoprene (inside) and plain washer.

Joint plate to strut use M10x25 hex sets, 2x plain washer and nuts



TYPE B: Standard to doubler

Joint strap x 1

Packers 5mmx2

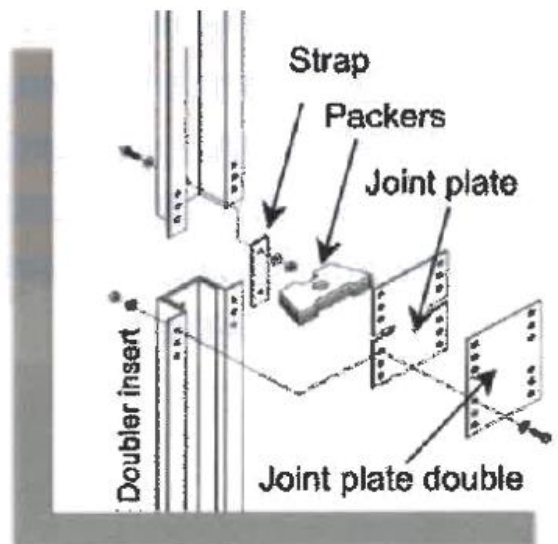
Packers 1mmx2+

Joint plate x 1

Doubler joint plate

Strut to wall use M10x30 hex sets neoprene (inside) and plain washer.

Joint plate to strut use M10x35 hex sets, 2x plain washer and nuts



TYPE C: Standard with doubler to standard with doubler

AS JOINT B

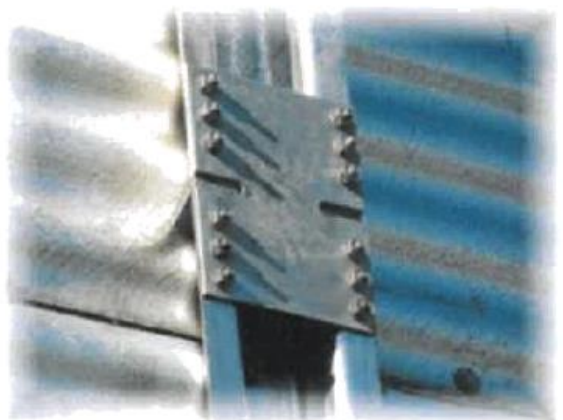


Photo of Joint Type A

Barrel assembly strut joints: continued

TYPE D: Standard with doubler to HD (Heavy duty strut)

Joint strap x 1

Packers 5mm x 2 (90mm depth)

Packers 1mm x 2+ (90mm depth)

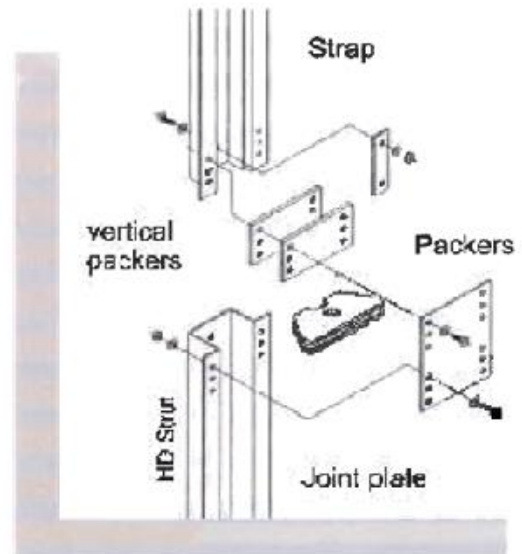
Joint plate x 1

Vertical packers x 2

Standard strut is 70mm deep a HD strut is 90mm deep hence the vertical packers (10mm).

Strut to wall use M10x35 hex sets neoprene (inside) and plain washer.

Joint plate to strut use M10x25 hex sets, 2 x plain washers and nuts. and M10x50 hex sets.



TYPE E: HDstrutto HDstrut

Joint strap x 1

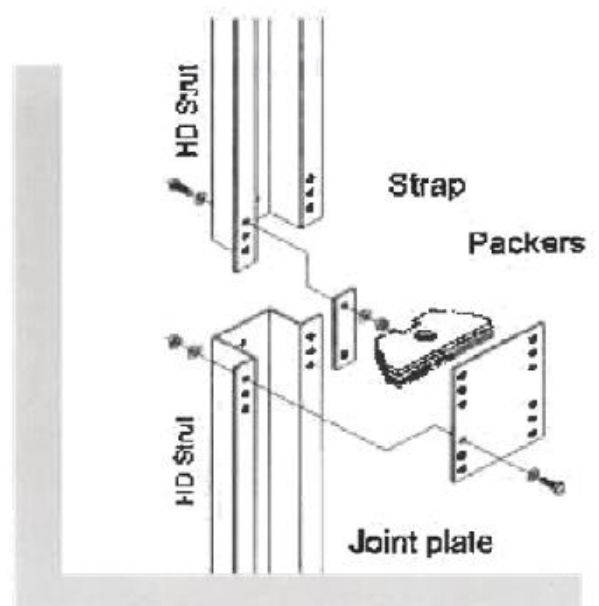
Packers 5mm x 2 (90mm depth)

Packers 1mm x 2+ (90mm depth)

Joint plate x 1

Strut to wall use M10x30 hexsets neoprene (inside) and plain washer.

Joint plate to strut use M10x30 hex sets, 2 x plain washers and nuts.



TYPE F: HD strut to HD strut with a standard doubler.

AS JOINT E

Barrel assembly strut joints: continued

TYPE G: HD strut with std. doubler to HD strut with HD doubler

Joint strap x 1

Packers 5mm x 2 (96mm depth)

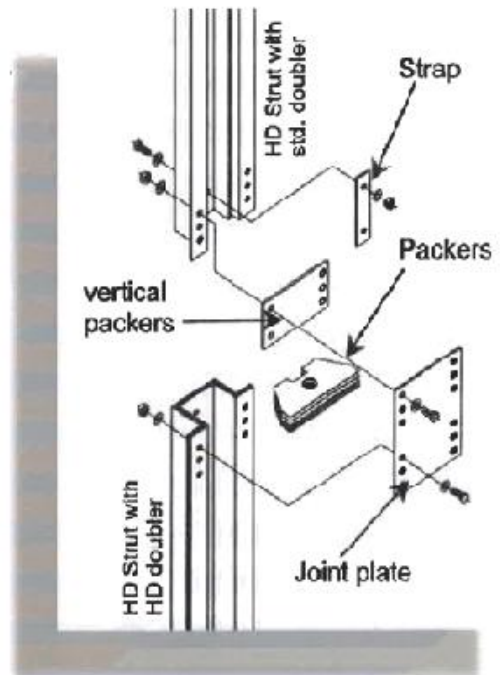
Packers 1mm x 2+ (96mm depth)

Joint plate x 1

Vertical packers 5mm x 1

Strut to wall use M10x35 hex sets neoprene (inside) and plain washer

Joint plate to strut use M10x35 hex sets, 2 x plain washers and nuts



TYPE H: HO strut with HD doubler to HD strut with HO doubler

Joint strap x 1

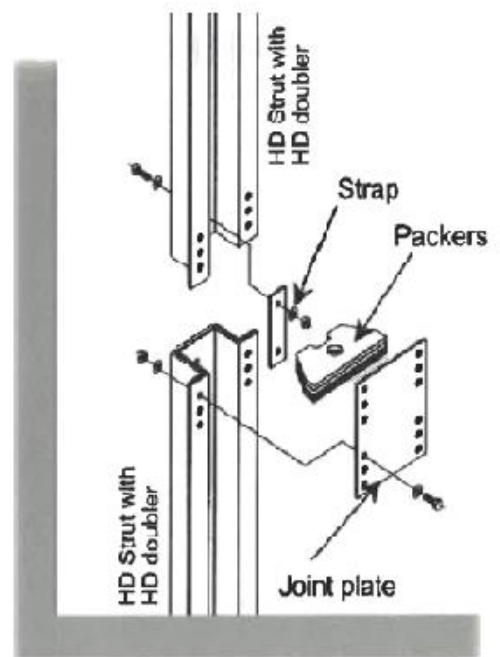
Packers 5mm x 2 (96mm depth)

Packers 1mm x 2+ (96mm depth)

Joint plate x 1

Strut to wall use M10x35 hex sets neoprene (inside) and plain washer

Joint plate to strut use M10x35 hex sets, 2 x plain washers and nuts



Erection procedure

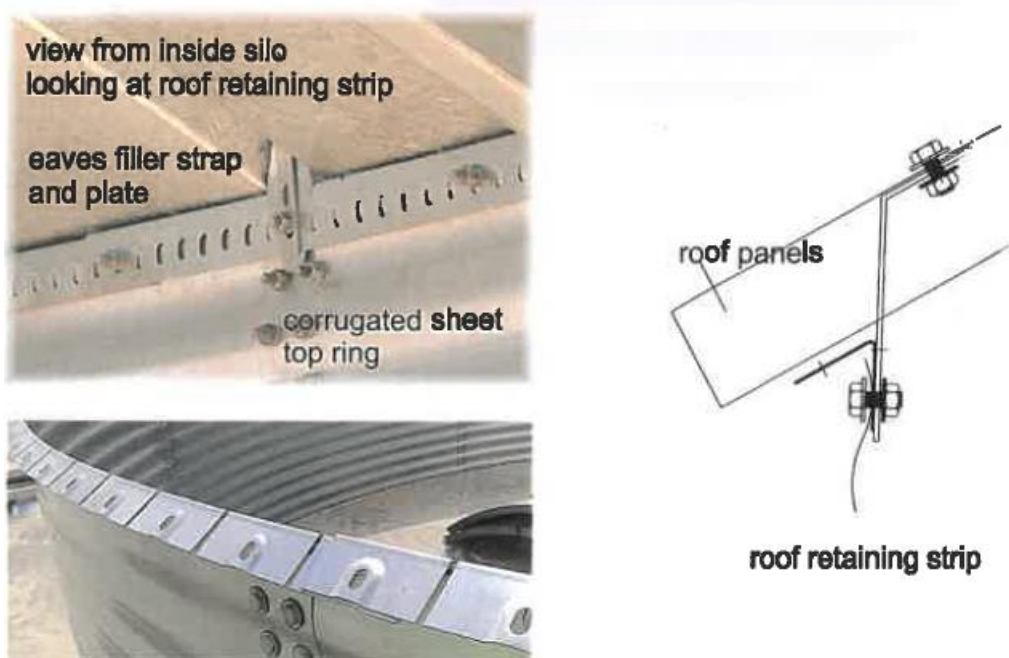
Bentall Rowlands Storage Systems Limited Silos are intended to be erected from the top downwards.

The first step is to assemble the top ring of wall sheets onto the intended silo base, these should be loosely bolted together with all the vertical overlaps in the same direction and with mastic sealant between if the silo is outdoor, in the majority of cases a vertical seam should be on centre-line or a sheet will span the centre-line.

All silos will have vertical stiffening struts these are positioned equally either side of the silo centre-line.

The silo roof structure and cover panels need to be assembled before any more rings of corrugated sheets are added. There is a roof retaining strip which attaches the roof panels to the wall sheets.

Bolt the roof retaining strip to the inside of the top ring of wall sheets using M10 x 20 hex sets, neoprene washers (outside) plain washers and nuts (inside). This roof retaining strip overlaps itself by two holes on the vertical leg.



Roof panels have a trapezoidal section for a joint, at the eaves position the space that this section leaves needs to be filled, there is a coffin shaped plate which in turn attaches to an eaves strap which bolts to the top ring of wall sheets up into the roof panel corrugation. Use M10 x 20 hex sets, neo & plain washers and nuts.

Roof assembly

Centre filling hatch should now be positioned and supported at the correct height above the top ring of wall sheet.

The height from the bottom of the first ring to the top of the roof cap are as follows.

4.0 Dia.....2400mm

5.0 Dia.....2689mm

6.0 Dia.....2978mm

7.0 Dia.....3266mm

8.0 Dia.....3555mm

9.0 Dia.....3843mm

On hopper silo's from 10.0 mm Dia. upward, there is an internal roof support structure.

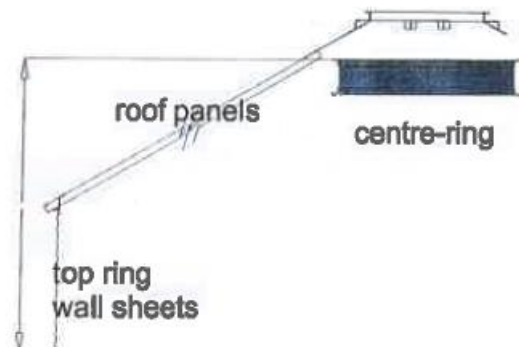
The internal structure is assembled first.

Dimension from top of the centre-ring to the underside of the first ring of corrugated sheets.

10.0 Dia.....3588mm

11.0 Dia.....3877mm

12.0 Dia.....4167mm



The centre ring which is the main support for all the internal roof structure needs to be positioned at the correct height from the floor, held on a crane, scaffold or centre pole.

The centre-ring has attached to it the top rafter brackets and the internal support brackets, these use common holes in the centre-ring and it is advisable to bolt these brackets into position before lifting the ring to its correct height. On all sizes of silo with structural roofs these brackets are bolted to the ring using M16 x 50 hex sets 2x plain washers and nuts.

Take a roof panel and bolt the narrow end under the centre hatch skirt, using the holes in the left hand corrugation only, using M10x25 hex sets, neoprene washer on the outside, plain washer and nut on the inside. Bolt the lower edge of the roof panel to the roof retaining strip using the same bolting arrangement.

Repeat this with 3 more panels approximately at quarters of the roof perimeter, then start to infill the gaps with the remaining panels.

DO NOT TIGHTEN UNTILL ALL PANELS/STRUCTURE ARE IN POSITION.

Erection procedure

Once the first ring of wall sheet is assembled with the roof retaining strip positioned, the roof cap can be held at its correct height, see page 20 for structured and non structured roofs.

Roof panels can now be attached, if opposite roof panels are assembled, this will help hold the roof cap and steady the construction.

Ensure roof panels are positioned correctly to allow eaves access hatches and roof vents to be in their positions.



Ensure that roof panels are overlapped in the same direction one corrugation under the adjacent panel, seal this corrugation with mastic and bolt using M10x20 hex sets, nuts and plain washer, neoprene washer on the outside.



Once all roof panels have been assembled, jacking can take place (some erectors prefer to add any catwalks, ladders, etc before jacking).

At this stage all the roof fixing can be tightened, do not tighten the top ring of wall sheets until the next ring is attached.



Roof assembly

Once the centre-ring is in position the main rafters can be attached to the rafter brackets, using M16x 30 hex sets, 2 x plain washers and nuts. These can be fixed individually or in pairs (with their cross purlins attached).

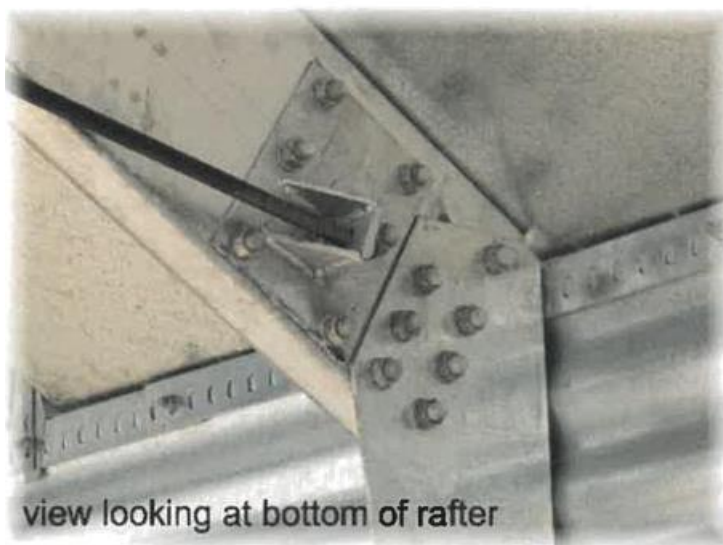
It is very important that you start the rafters in the correct position on the bottom end because they attach to a bracket on the inside of the silo wall which will back onto an external stiffening strut.

Once there are 4 pairs of rafters in position at 90 degrees to each other the centre-ring should be self supporting. Because of the length of these rafters and the fact that all the structure cannot be attached at the same time, these rafters will tend to curve slightly to bring them straight there is some rafter cross bracing supplied which fixes to the bottom flange of 4 pairs.



view looking up at centre-ring

roofstructure top bracket
rafter top bracket
centre-ring
main roof rafter
tie rod truss (20.0M +)



view looking at bottom of rafter

bottom wall bracket
Use M10 x 50 hex sets through the silo wall and into a vertical strut.
Use 1M10 nut as a spacer between this bracket and the wall sheet.

Roof assembly: continued

The silo roofs from 10.0 M diameter to 17.0 diameter are designed to use one main rafter per wall sheet, i.e. a 10.0 M diameter has 10 rafters, an 11.0M diameter has 11 rafters, and soon.

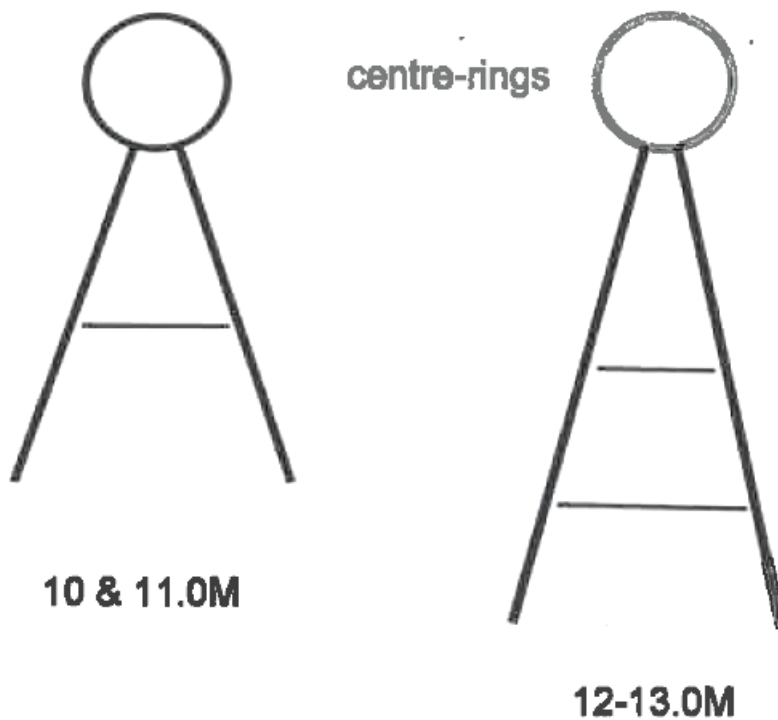
18.0 M diameter and 19.0 diameter again have 18 and 19 rafters respectively, but they also have an intermediate rafter in between the main rafters.

20.0M diameter and upwards have the same number of main rafters as wall sheets and intermediate rafters between these and also a tie rod truss arrangement with a centre post.

The rafters have cross purlins fixed between them circumferentially bolted to them using purlin brackets, these use M12 x 30 hex sets 2 x plain washers and nuts both to fix the purlin to the bracket and the bracket to the rafter.

The longer the main rafter the more cross purlins it will have.

Plan view on roof rafters and purlins:



Depending where it is position some cross purlins will be fixed with either a two bolt or a three bolt bracket onto the main rafter.

Roof assembly: continued

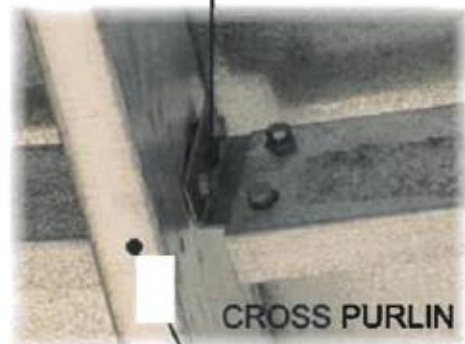
The intermediate roof rafter fixes to a cross purlin at the top with an angle bracket using M12 x 30 hex sets, 2 x plain washers and nuts.

At the bottom end it fits in the same way the main rafter fits, to an internal wall bracket which is not full sheet depth as the main rafter bracket is.

**DO NOT TIGHTEN THE ROOF
STRUCTURE AT THIS STAGE**

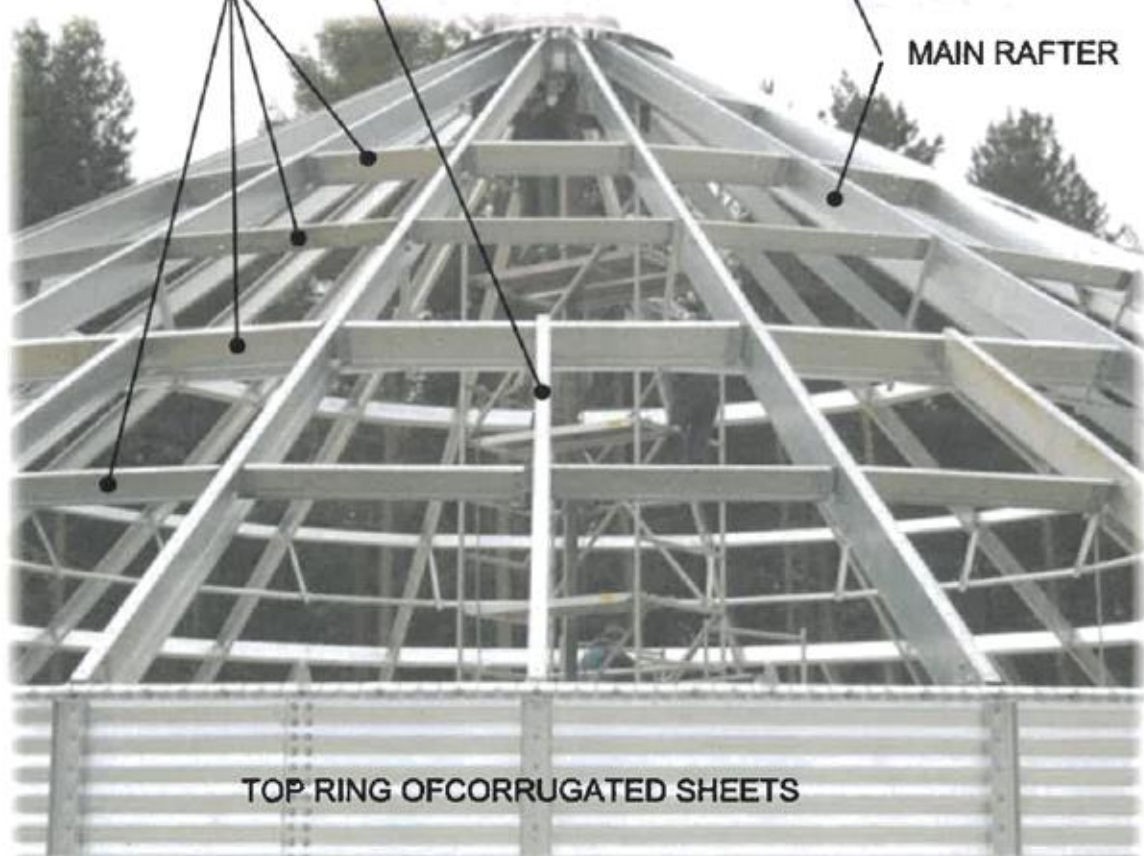
INTERMEDIATE RAFTER
CROSS PURLINS

PURLIN FIXING BRACKET



CROSS PURLIN

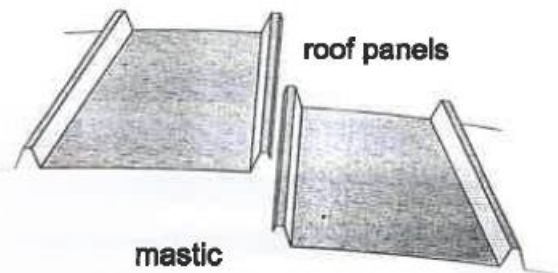
MAIN RAFTER



TOP RING OF CORRUGATED SHEETS

Roof assembly: continued

Start roof cover panels with the lower most panel and work round the silo, remember to leave joints loose, once the bottom ring of panels are secure to themselves and to the rafters, the next ring of panels can be attached.



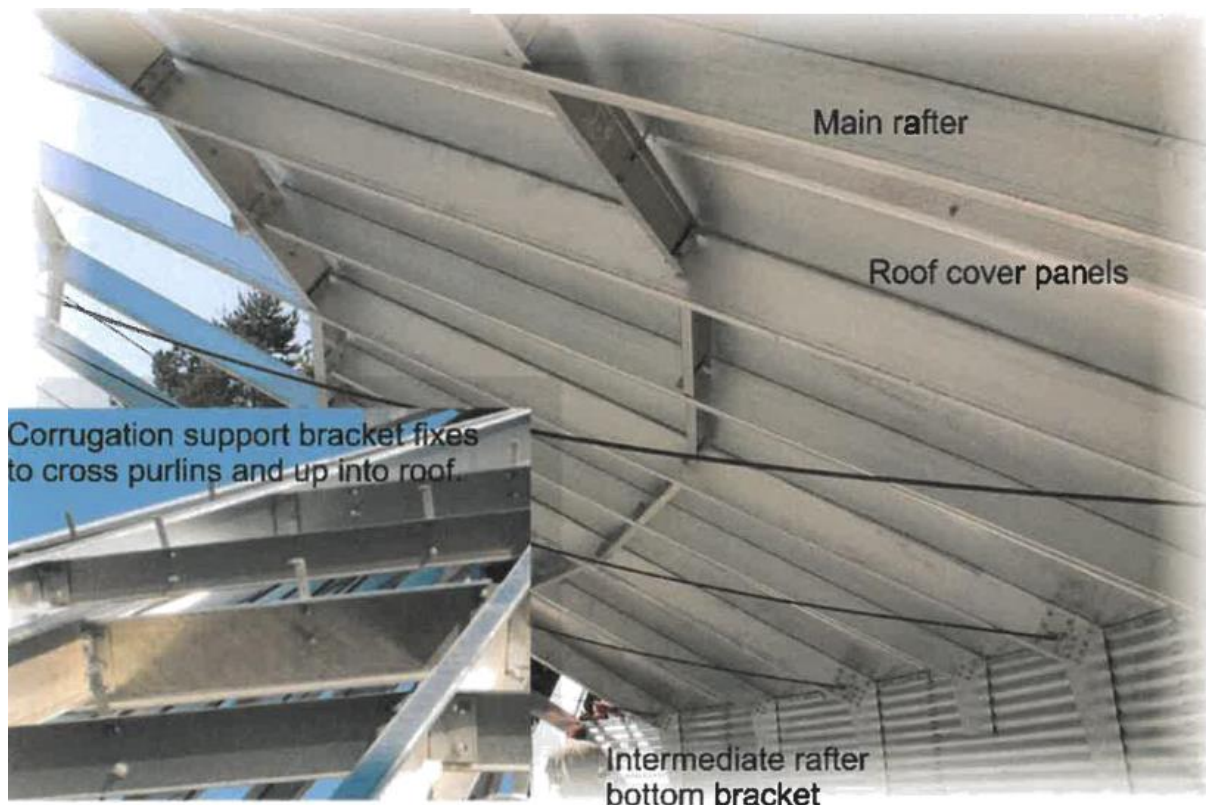
The roof panels overlap each other as shown right with a bead of mastic between panel laps. Use M10 x 20 hex sets, neo & plain washers, nuts

Be aware of items that go into the roof i.e. access hatches, roof vents, temperature monitoring access.



intermediate rafter

Cross purlin



ONCE ALL COVER PANELS ARE ON TIGHTEN STRUCTURE

Barrel assembly

When the silo roof is complete the barrel of the silo can progress, attach “A” frame lifting jacks. Bentall Rowlands recommend that there is one jack per wall sheet, attached to vertical strut.

ie. on a 50m hopper there would be 5 jacking points, 6 on a 6.0 m and so on.

It is the erectors responsibility to ensure that all lifting equipment and fitting are safe for use and comply with all the relevant health and safety requirements.

It is very important to achieve an even lift, so that jacks are loaded equally, this will also help keeping the barrel circular while being lifted.

When attaching the next ring of wall sheets ensure they are overlapped correctly and the correct thickness is used, there will be a strut and sheet build up provided separately to this instruction manual.

See page 13 and 14 and 15 for the correct overlapped joints.



Barrel and entablature

Hopper bottom silo's are intended to be erected in four basic stages, these being:

1. The rood assembly and barrel is built on the ground adjacent to the position where the entablature and the final position of the hopper.
2. The entablature legs are then erected in the position on the hopper base and fitted with all the necessary cross braces, etc.
3. The body assembly is then lifted onto the hopper legs.
4. The hopper panels are them assembled into position under the silo body.



Catwalks, ladders, platforms can be assembles on the top of the hoppers when they are at ground level.

Care must be taken as catwalks etc may make jacking unstable.



Do not fully tighten entablature until barrel has been lifted and positioned.

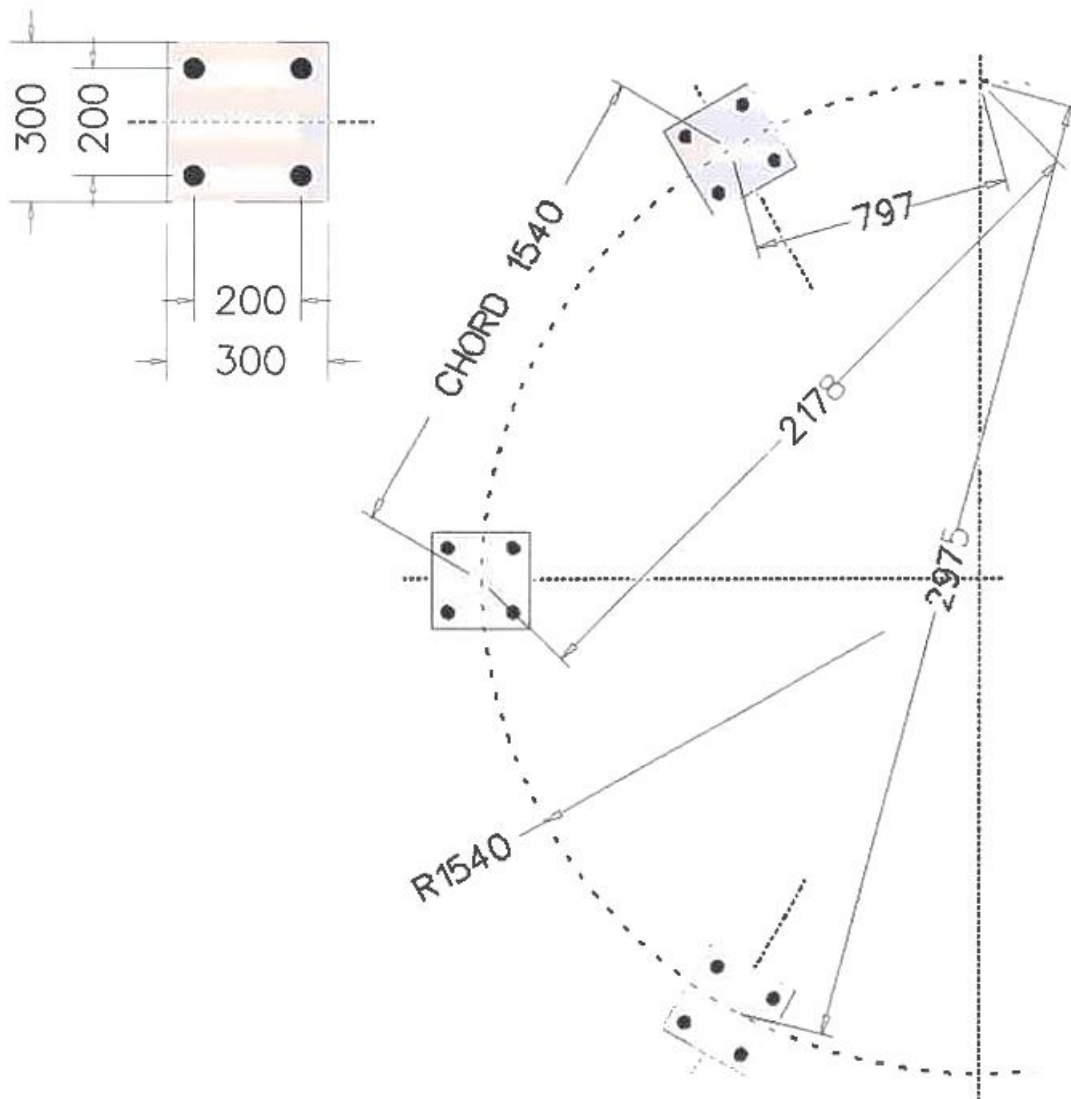
It is usual to lift the barrel with the base ring and hip ring attached ready to sit on top of the entablature structure: This also help to keep the barrel circular.

3.0. M DIA HOPPER

No. of legs 6

Angle between legs 60 degrees

On standard range of hoppers there are 4 holding down bolts per legs

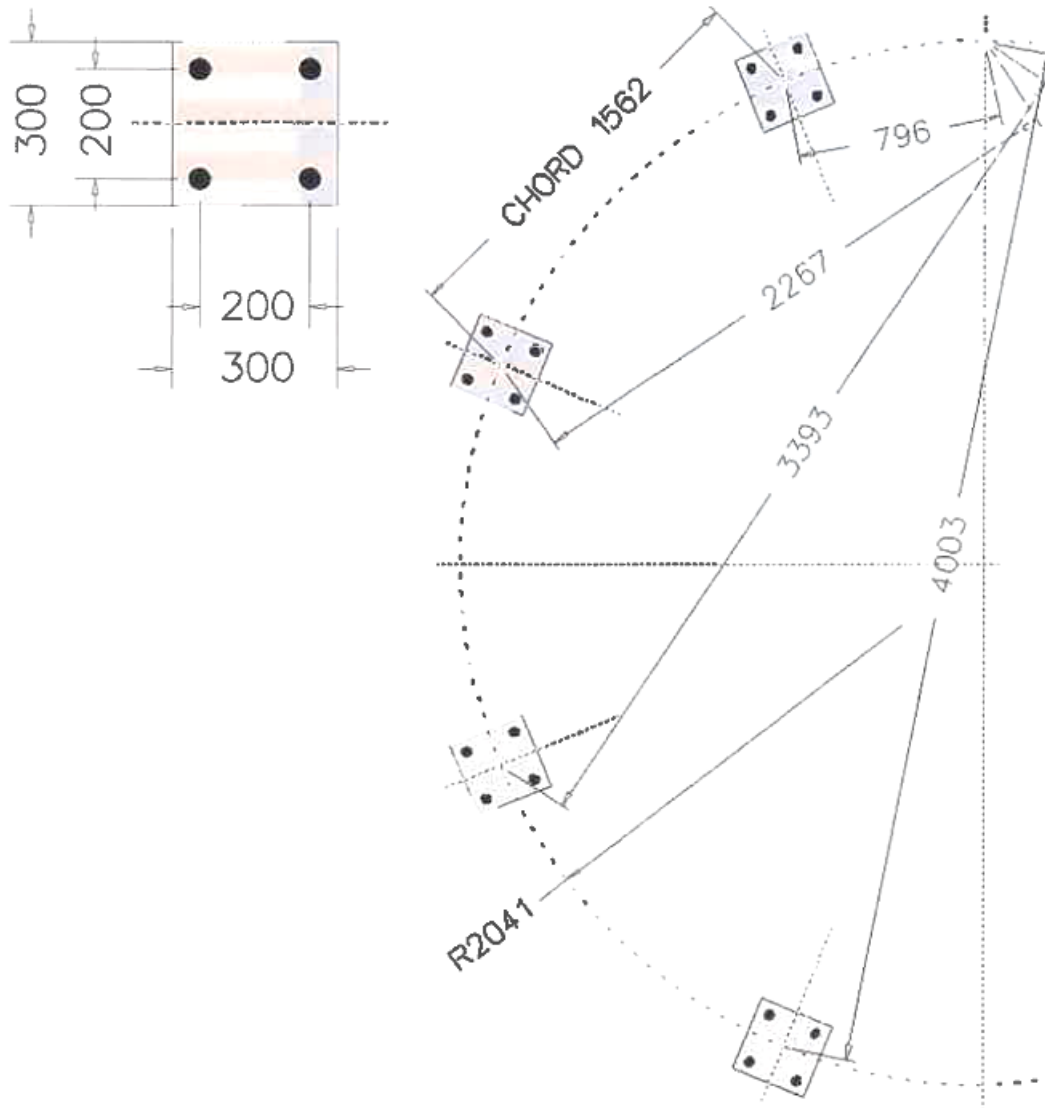


4.0. M DIA HOPPER

No. of legs 8

Angle between legs 45 degrees

On standard range of hoppers there are 4 holding down bolts per legs

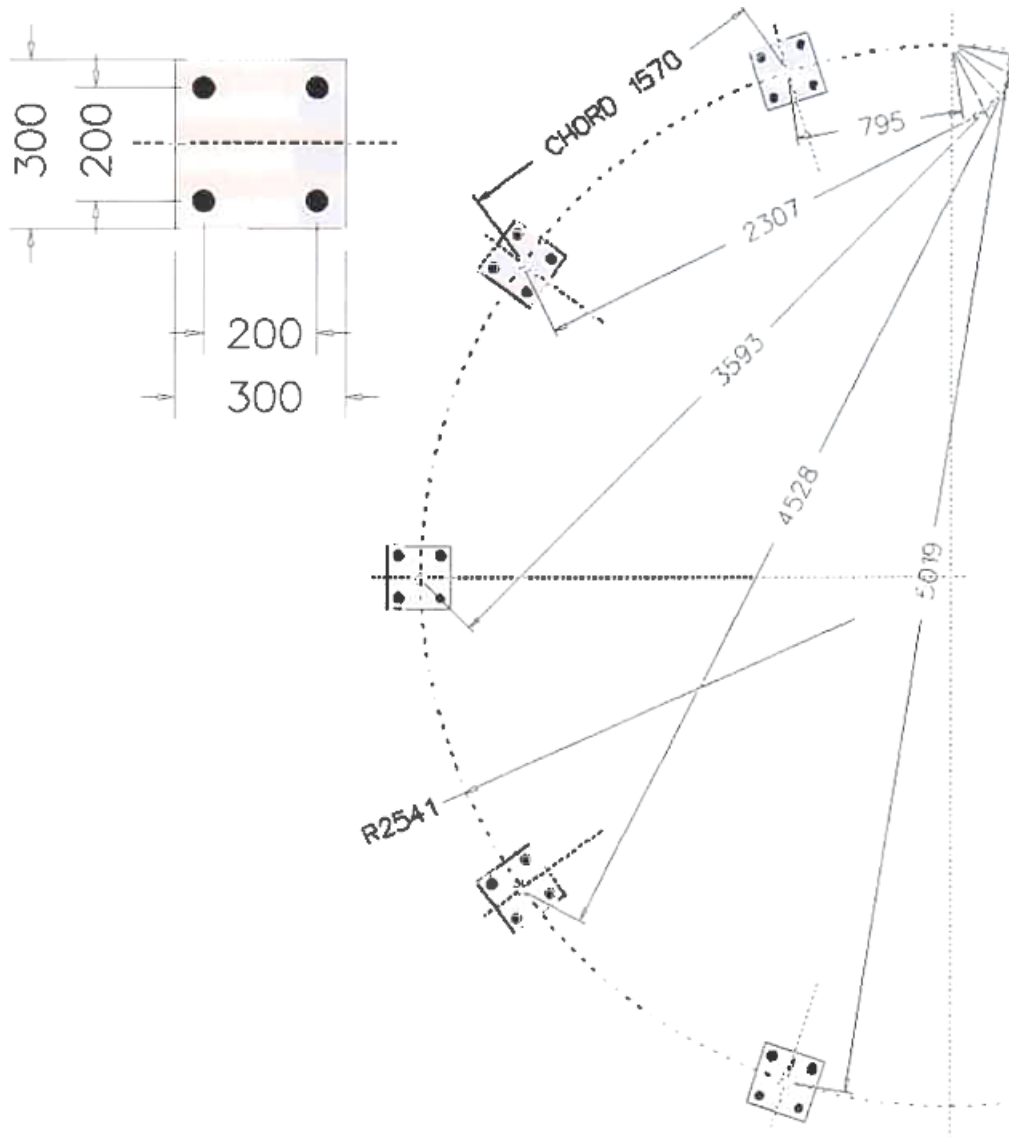


5.0. M DIA HOPPER

No. of legs 10

Angle between legs 36 degrees

On standard range of hoppers there are 4 holding down bolts per legs

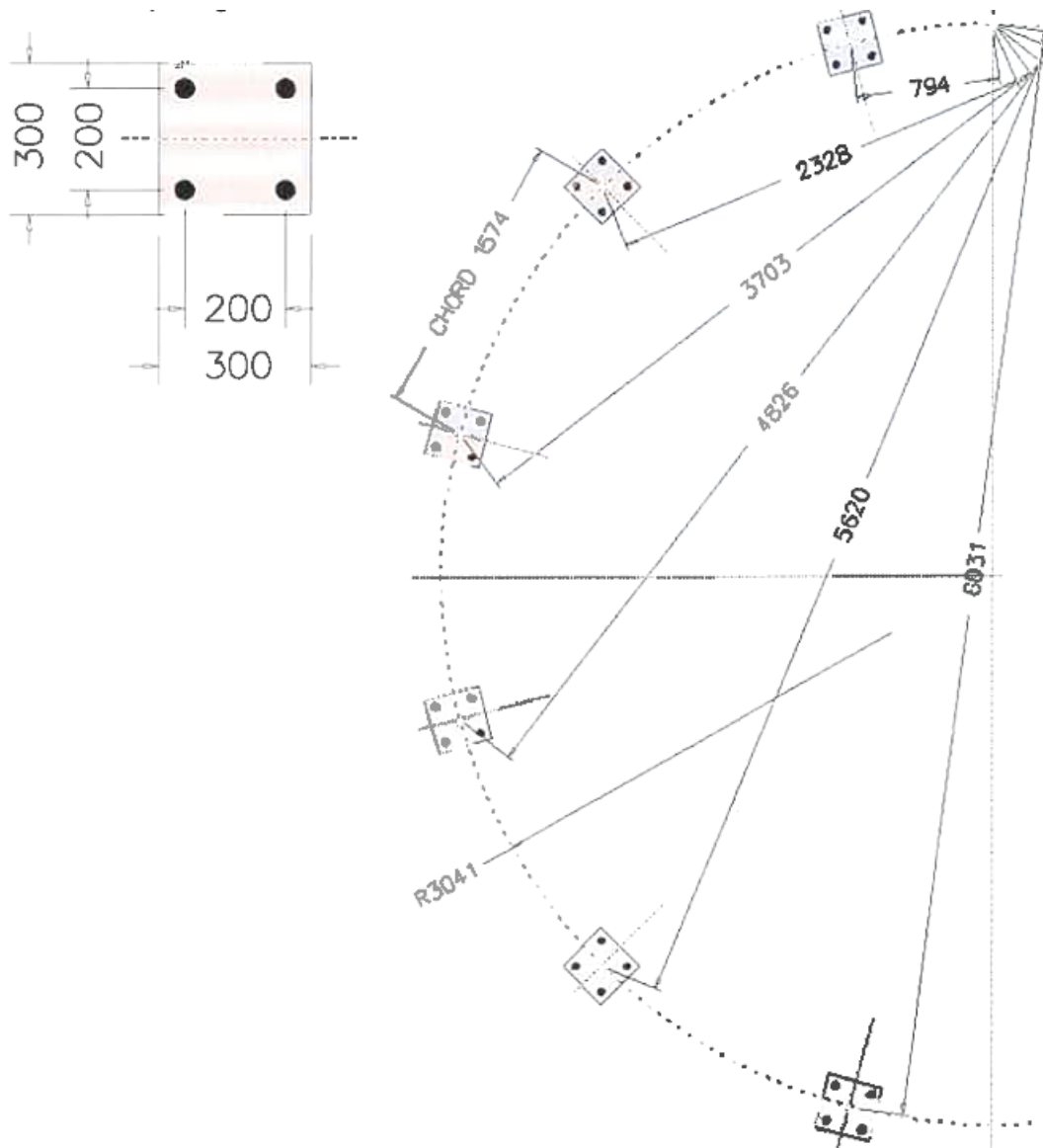


6.0. M DIA HOPPER

No. of legs 12

Angle between legs 30 degrees

On standard range of hoppers there are 4 holding down bolts per legs

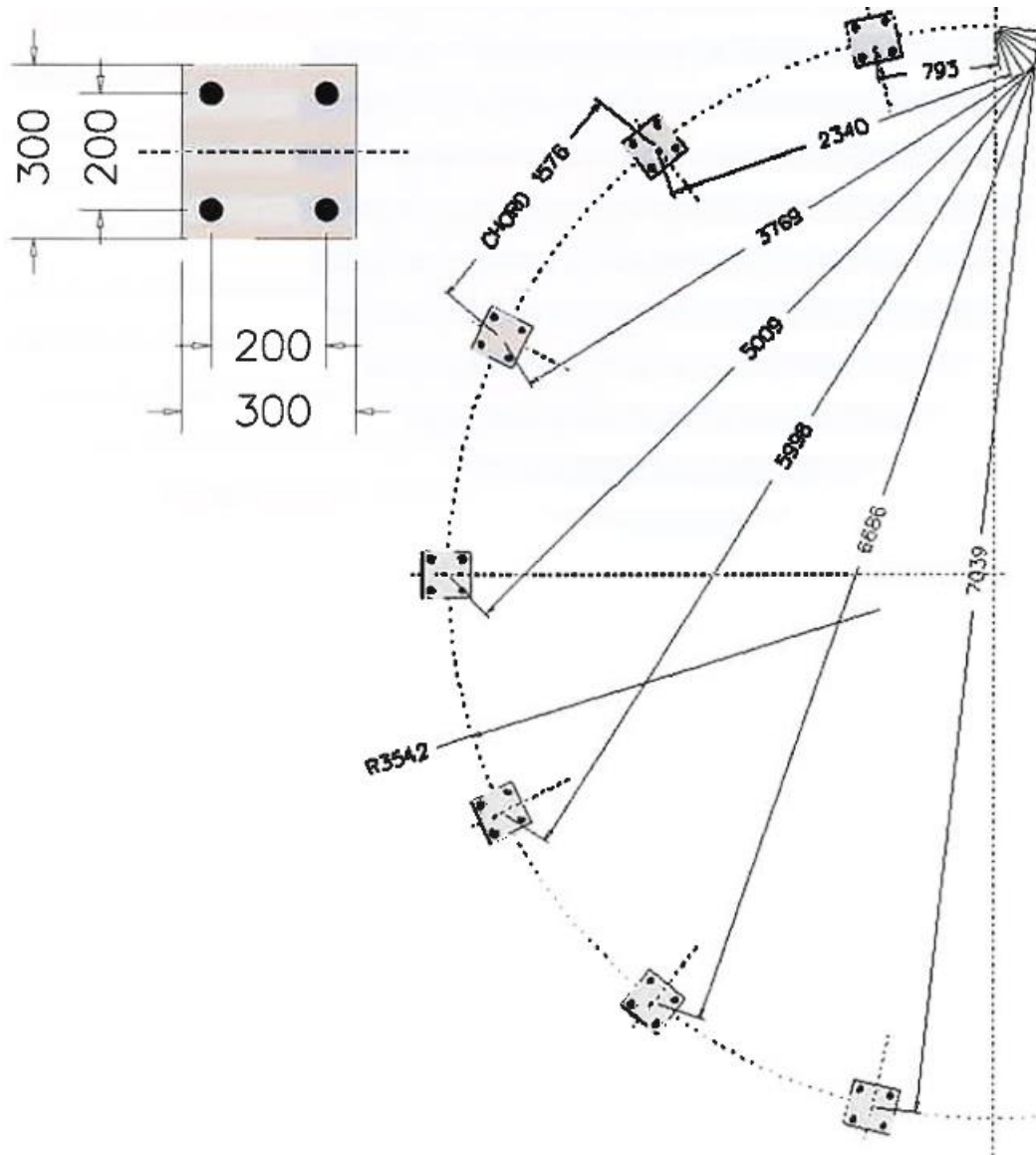


7.0. M DIA HOPPER

No. of legs 14

Angle between legs 25.714 degrees

On standard range of hoppers there are 4 holding down bolts per legs

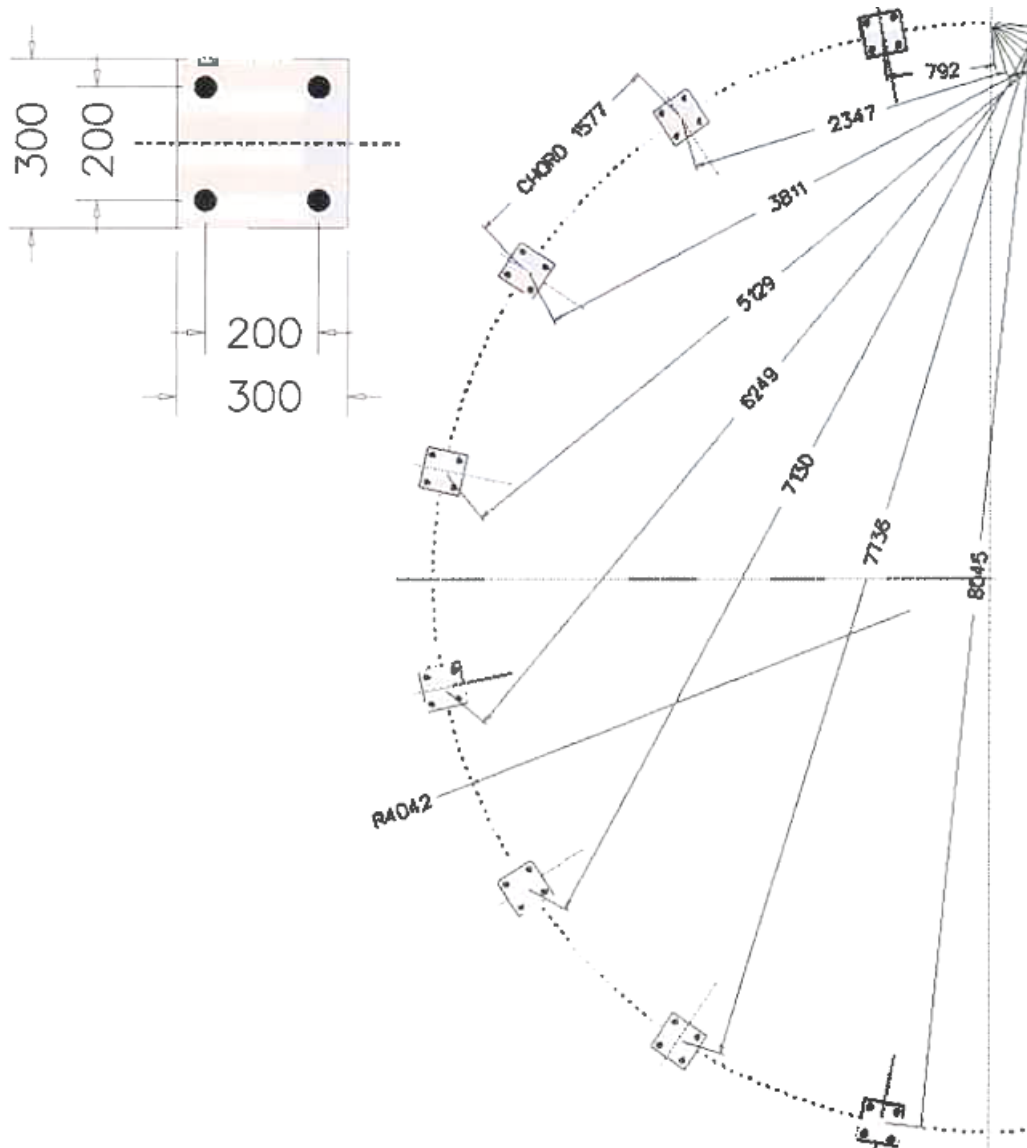


8.0. M DIA HOPPER

No. of legs 16

Angle between legs 22.5 degrees

On standard range of hoppers there are 4 holding down bolts per legs

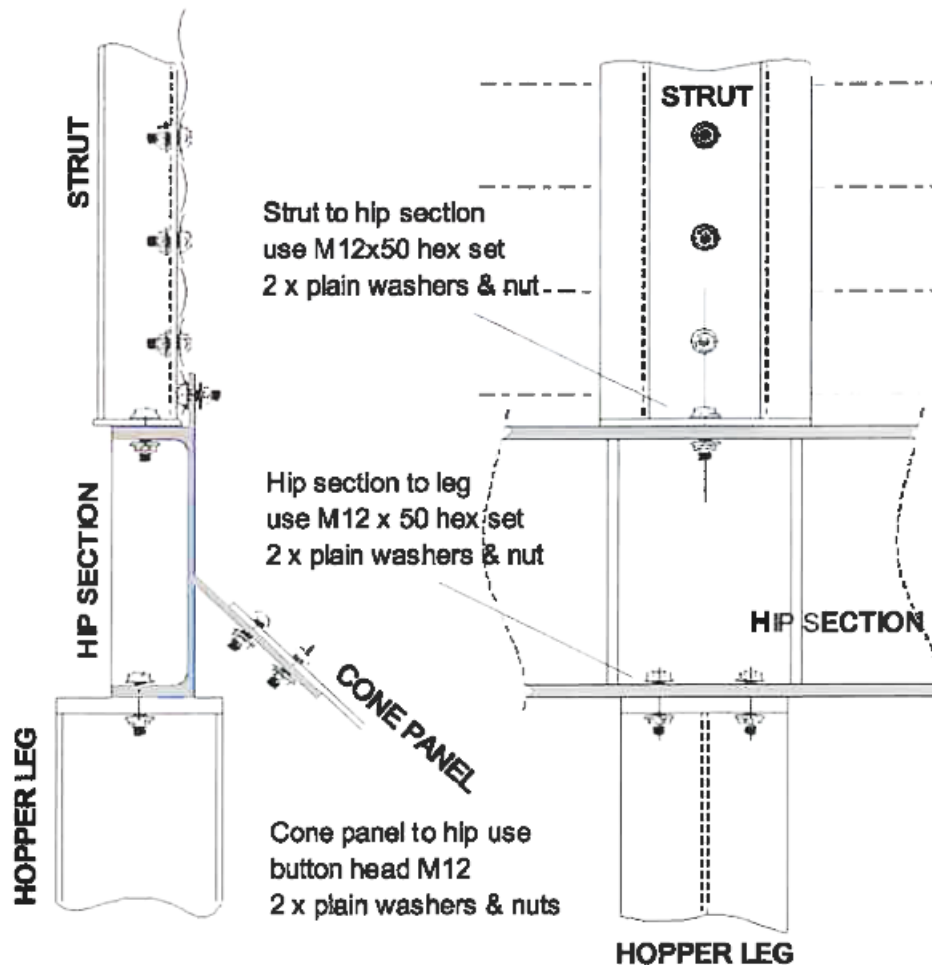


Hip compression ring

The Hip ring is attached to the bottom ring of corrugated wall sheets prior to lifting onto the hopper leg structure.

Depending on the size of the hopper and the hip ring section, the sections are bolted together with hex head sets, plain washer x2 and hex nuts through end plates. See bolt location lists for correct size for your particular hopper.

For strut fixing to wall see page No.12



NOTE: Depending on hopper size and specifications cone bolts may be dome head silo bolt, which do not require a plain washer under the head, see bolt location document.

Legs & bracings

Legs and bracing should be assembled prior to lifting the hopper barrel into position, DO NOT TIGHTEN bolts in structure until barrel is positioned.

Cross braces are fitted to legs either by a cross brace bracket bolted to the leg (see bolt location for size and number) or a welded plate to the leg, this will depend upon the size and specification of your hopper.



The size of the cross bracing is again dependant upon your size and specification of the hopper, standard hoppers use equal angle sections and are fixed using M12x40 hex head sets 2 x plain washer and nut. See bolt location document.

In some cases cross bracing needs to be removed to avoid conveyors and equipment,

DO NOT DO THIS UNTIL CONFIRMATION FROM BRSS IS GIVEN



Hopper: continued

Once the legs are up and in position, and the hopper barrel is complete with hip ring, the barrel can be lifted into position, it is the responsibility of the erection company to ensure the correct health and safety procedures are followed, lifting brackets comply with the necessary safety standards.

Some erection company's lift the barrel with hip ring onto the legs, then install the hopper panels, some like to install the hopper panels onto the hip ring section prior to lifting, (see photo below).



Hopper being lifted into position from inside the silo, brackets attached to hip section.

Top section of hopper sheets attached prior to lifting.



Hopper being lifted externally off the hip section, prior to any hopper panels being fitted.

LIFTING WEIGHTS FOR GUIDENCE ONLY (include hip section)

4.0m dia	5.0m dia	6.0m dia	7.0m dia	8.0m dia
x2 ring 1500 kg	x2 ring 2000 kg	x2 ring 2500 kg	x2 ring 3100 kg	x2 ring 3600 kg
x4 ring 1800 kg	x4 ring 2400 kg	x4 ring 3900 kg	x4 ring 3700 kg	x4 ring 4400 kg
x6 ring 2300 kg	x6 ring 3000 kg	x6 ring 3600 kg	x6 ring 4700 kg	x6 ring 5700 kg
x8 ring 2700 kg	x8 ring 3650 kg	x8 ring 4400 kg	x8 ring 5300 kg	x8 ring 6700 kg

Hopper: continued

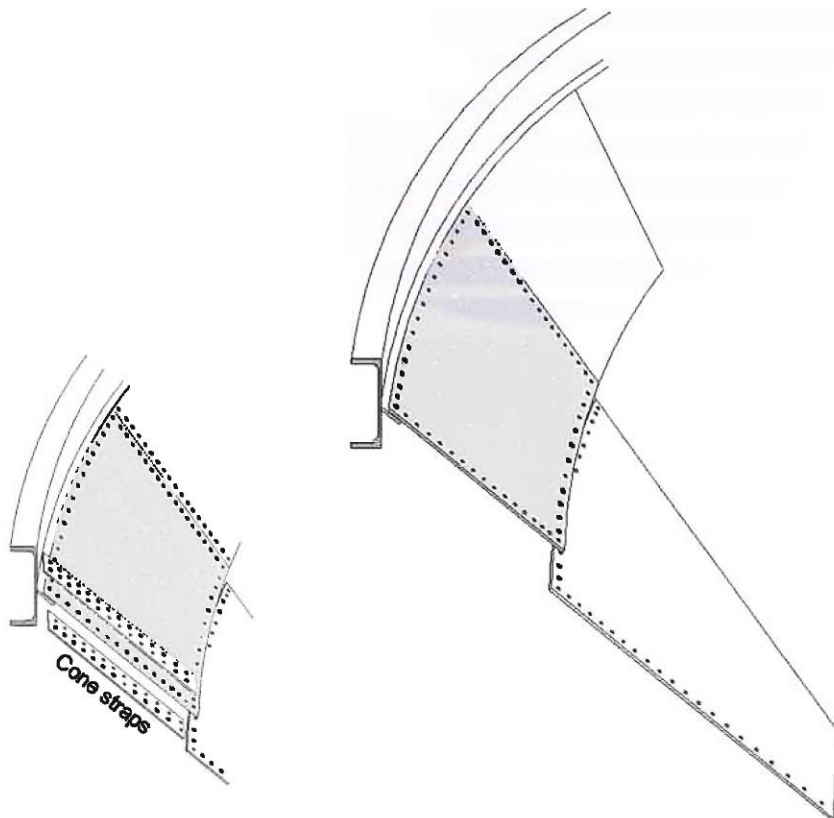
Hopper panels bolt to the hip ring starter using M12 dome headed sets, Id specified as button heads a plain washer under the head and nut is required, if specified as domed headed silo bolt is specified this doesn't require a plain washer under the head.

4.0, 5.0 and 6.0 m dia. 45 degree hoppers utilise one panel from hip to one piece cone assembly.

7.0 and 8.0 m used top panels, intermediate panels (as shown below) overlap panels for product flow.

Each hopper is designed individually for the product to be stored, therefore panel thicknesses and bolt sizes can vary, see bolt location document for your individual hopper.

Cone panels up to 3mm thick are generally overlapped joints with single bolt runs. If design dictates these hopper panels will utilise a strapped joint with a double row of bolts. See below.



Cone panel straps.

The internal strap is longer than the external strap, see bolt location for correct fixing.

Hopper: continued

All hopper bottom silos finish with one piece cone with a flange to suit customer requirements or a rack and pinion gate.



The bottom one piece cone will require drilling through into the hopper panels in order to align the bottom flange with any conveying equipment.

DO NOT TIGHTEN HOPPER BOLTS UNTIL PANELS ARE ASSEMBLED

Final operations

Detach and remove all lifting equipment etc.

Check round for any signs of loose or missing bolts, a silo viewed from the inside on a bright day may reveal pinholes of light indicating missing bolts.

Ensure door inner and outer skins are fitted along with door tie bars.

Are any parts left over - if so, you may have missed a part out somewhere - find out.

MAKE SURE ALL SAFETY AND WARNING SIGNS ARE FITTED

Revisions

Date	Revision
18/04/2018	Minimum and maximum torque
08/05/2018	Configuration of the silo wall sheet joint when two sheets are required