

# Design & Procurement Guidelines for Sub-Sea Pipeline Securing Assemblies in Arabian Gulf



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## **Introduction**

This document highlights pertinent design and procurement issues relating to sub-sea pipeline securing assemblies in the Arabian Gulf. It presents technical, environmental and operational factors that may influence the design and specification of each system.

## **Preventing Premature Failure through Material Selection**

Up until recently sub-sea pipe securing assemblies have been designed with Grade 80 products in mind however, this equipment is designed for lifting applications in air and is entirely unfit for marine use. Grade 80 chains and fittings (such as Crosby Spectrum 8 or equivalent) are alloy steel material with high ultimate tensile strength, and as such are prone to hydrogen embrittlement in sub-sea environments. High intergranular strength results in hydrogen cracking and ultimately premature failure, as previously experienced by clients in the Arabian Gulf.

The process of galvanising Grade 80 chain and fittings is likely to cause micro-cracking. Furthermore, it is difficult to achieve a truly homogeneous coating through hot dipping and this combined with hydrogen embrittlement promotes preferential pitting and breakdown of material grain boundaries, resulting in higher corrosion rates and ultimately premature failure.

Finally, due to its high ultimate tensile strength Grade 80 chain and fittings are more susceptible to microbiological attack, and rapid biological development is likely to occur in the warm waters of the Gulf.

Consequently, marine grade equipment should be used exclusively in sub-sea applications to achieve longer service life and avoid the metallurgic effects experienced by Grade 80 products (Crosby or equivalent) in water.

Marine chains have been developed specifically for underwater use. Carbon manganese and low alloy steels limit ultimate tensile strength, increase ductility, eliminate the risk of hydrogen embrittlement and thus service life can be significantly improved. Stud link chain has increased strength as a consequence of the stud and is resistant to deformation under lateral loading. Furthermore, by specifying an appropriate marine grade material throughout preferential wear through dissimilar metal corrosion is controlled.

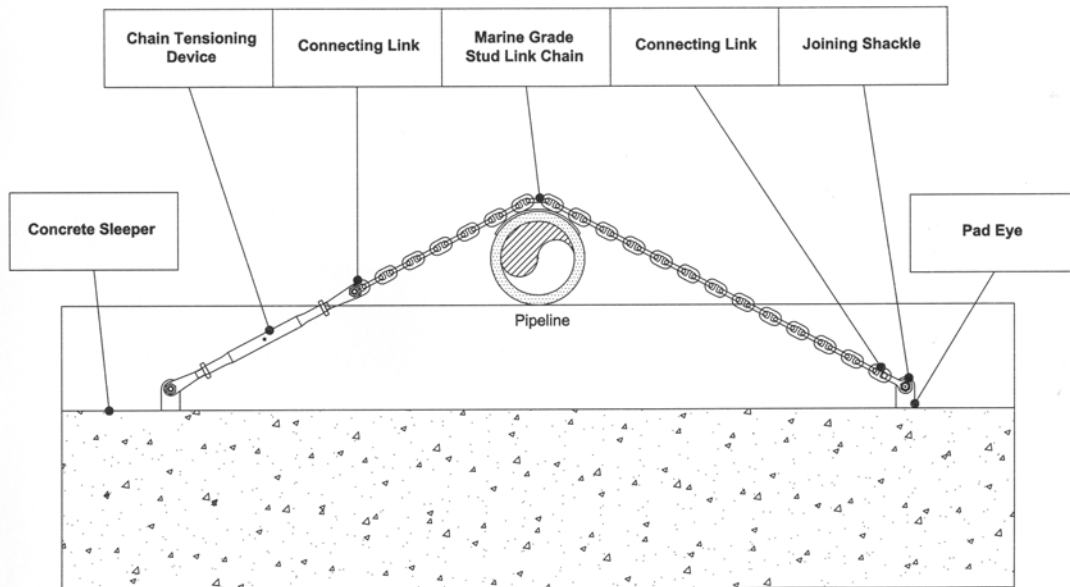
## **A Highly Corrosive Environment**

The Arabian Gulf is a highly saline environment where particularly warm chloride waters create extremely corrosive conditions. This is increasingly prevalent in the southeastern Gulf where high incidences of desalination plants significantly increase the water's salt content, so much so extreme corrosion and the destruction of marine life is a serious concern.

There is evidence to suggest that steel reacts more readily with concrete in sub-sea conditions creating higher corrosion rates and limiting service life. This phenomenon may therefore require further detailed investigation in relation to specific projects.

## Configuration of Pipeline Securing Assemblies

The general system arrangement (shown below) includes as a minimum a concrete sleeper c/w cast-in pad eyes, joining shackles, stud link chain, connecting links and a chain-tensioning device.



### *System Specification*

The client should be responsible for determining the appropriate safe working load and pad eye details for each sleeper, including concrete and material grades. Thereafter each component is selected according to the specified SWL and overall 'fit' within the assembly.

### *Easy Handling & Assembly*

In order to ensure ease of handling and assembly during installation a higher grade of marine chain and fittings are recommended, in order to achieve the required SWL whilst minimising the size and weight of each component. Higher-grade chains present better wear characteristics and thus longer service life. Furthermore, constituent components are selected for ease of assembly.

### *An Indeterminable Chain Length*

It is preferable to terminate each securing chain with appropriate end links however, the position and orientation of the pipeline on each sleeper cannot be predetermined. As the overall adjustment available on the chain-tensioning device is limited each chain must be cut to an appropriate length and consequently cannot be supplied with end links. Connecting links are therefore required.

### *'D' & Bow Type Shackles*

Shackles for joining into pad eyes should be selected to suit both appropriate SWL and lug dimensions. To increase service life and limit wear, design of the pad eye should facilitate good 'fit' with the required joining shackle.

### *Chain Tensioning Device*

In order to minimise wear and ensure security of the pipeline on the sleeper a chain tensioning device is installed within the system. The recommended closed body turnbuckle imposes a restrictive force on the pipeline whilst tensioning the chain assembly, thus limiting wear. Locking nuts enable tension to be maintained and limit the risk of loosening over time. The closed body design prevents thread damage, unlike open body models that cannot be loosened if threads are damaged during installation/use. The jaw configuration facilitates a range of connections and, more importantly, allows connection directly into the pad eye. If necessary, body and thread lengths can be varied to provide tailored adjustment and all threads are greased to ensure ease of assembly/installation.

### *Connecting Links*

Securing chains are cut at an appropriate length to suit each sleeper and therefore cannot be supplied with end links. Furthermore, for ease of handling during installation a higher chain grade is recommended allowing chain size to be minimised. Consequently, joining shackles cannot be fitted directly into the common chain link and connecting links are required. Due to the differential between the chain and joining shackles detachable pear shaped connecting links are recommended.

### *Cathodic Protection*

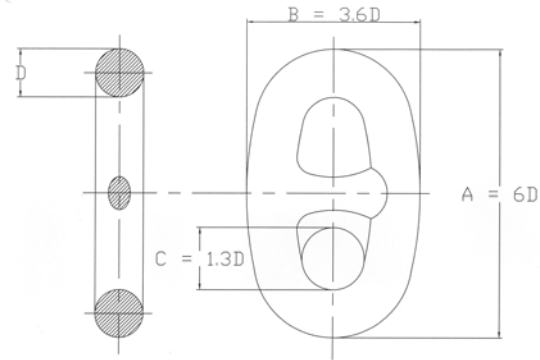
Each system component is protected by galvanising to BS1461. This galvanic coating will generate a cathodic effect across the entire assembly however, the resultant protection will be limited due to the highly corrosive environment. It is impractical to re-galvanise the system on a regular basis therefore we recommend additional protection through the use of GWIMP Anodes placed at regular intervals along the chain. Furthermore, GWIMP Anodes can be replaced sub-sea and are therefore ideal for protecting permanent fixtures.

### *Protecting the Pipeline from Chafing*

Currently a neoprene rubber sheet is placed between the chain and pipeline however, in order to overcome problems where the sheet is either dislodged or chain relocates itself we recommend the chain is passed through a neoprene rubber tube.

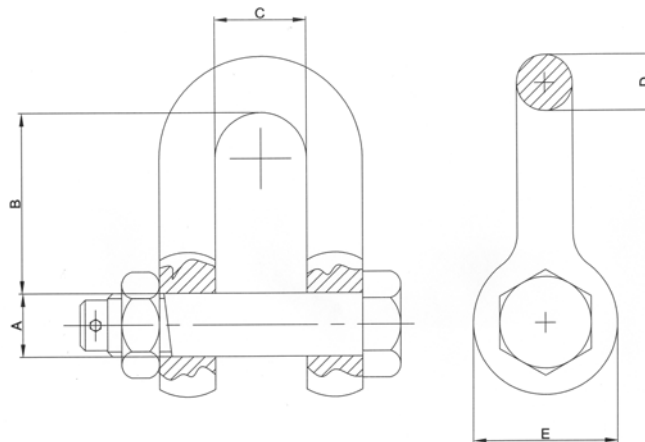
## Component Specifications

### Marine Grade Stud Link Chain



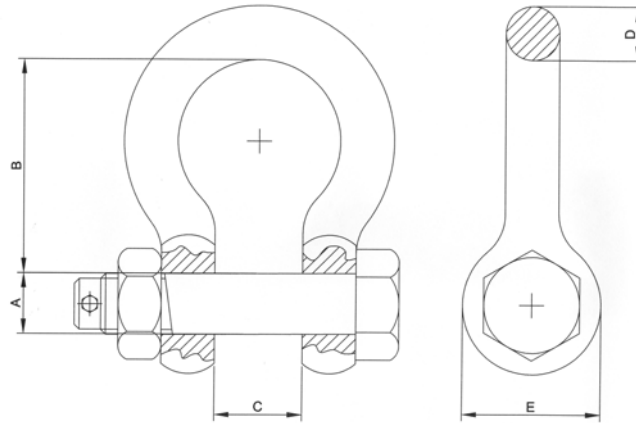
Part Ref.	A (mm)	B (mm)	C (mm)	D (mm)	SWL (MT)
<b>GWSC319</b>	114	68	24	19	<b>14</b>
<b>GWSC3205</b>	123	73	26	20.5	<b>16</b>
<b>GWSC322</b>	132	79	28	22	<b>18</b>
<b>GWSC324</b>	144	86	31	24	<b>22</b>
<b>GWSC326</b>	156	94	33	26	<b>26</b>

### Safety Chain Shackle



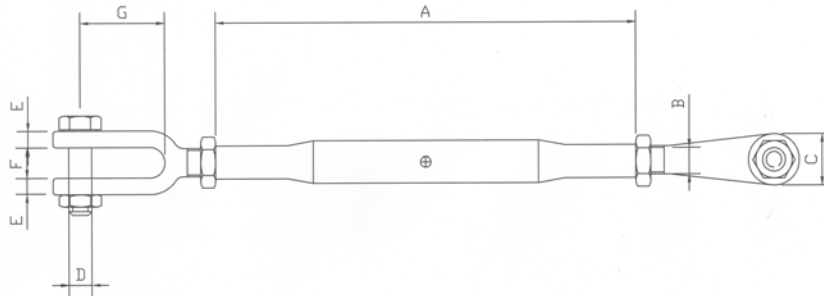
Part Ref.	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	SWL (MT)
<b>GWDS135</b>	38	114	57	35	82	<b>13½</b>
<b>GWDS17</b>	42	124	60	38	92	<b>17</b>
<b>GWDS20</b>	48	136	66	42	102	<b>20</b>
<b>GWDS25</b>	50	146	73	44	108	<b>25</b>

## Safety Anchor Shackle



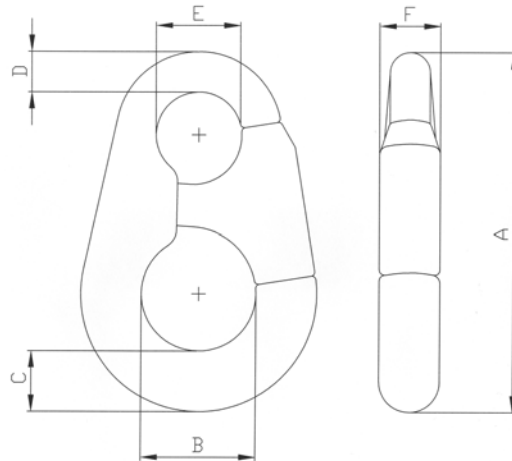
Part Ref.	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	SWL (MT)
<b>GWBS135</b>	38	133	57	35	82	<b>13½</b>
<b>GWBS17</b>	42	146	60	38	92	<b>17</b>
<b>GWBS20</b>	48	165	66	42	102	<b>20</b>
<b>GWBS25</b>	50	178	73	44	108	<b>25</b>

## Closed Body Jaw/Jaw Turnbuckle



Part Ref.	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	SWL (MT)
<b>GW302T12</b>	407	44	80	36	24	50	110	<b>12</b>
<b>GW302T17</b>	407	50	92	42	26	54	127	<b>17</b>
<b>GW302T20</b>	410	56	108	48	30	67	135	<b>20</b>
<b>GW302T25</b>	410	64	120	56	32	70	135	<b>25</b>

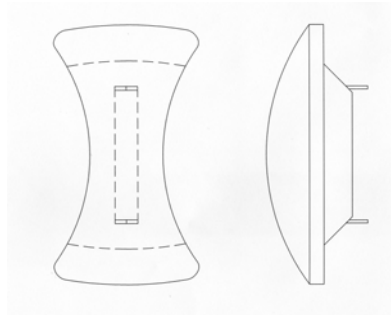
### Detachable Pear Shaped Connecting Link



Suitable for use with a range of chain sizes

Part Ref.	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	SWL (MT)
<b>GWPL32</b>	194	70	32	24	48	40	<b>22</b> max.
<b>GWPL33</b>	238	92	38	30	64	46	<b>34</b> max.

### GWIMP Anode



Supplied in pairs with appropriate dimensions to suit Stud Link Chain Cable

Fe	0.12 max
Si	0.10 max
Cu	0.006 max
Zn	2.8 - 6.5
In	0.01 - 0.02
Ti	0.025 max
Others (each)	0.02 max
Aluminium	Remainder
Capacity DNV RPB401 at 20°C " 1°C	2500 Ampere Hrs/Kg min DNV RPB401 (1993) Appendix A
Closed Circuit Potential DNV RPB401 at 20°C " 1°C	-1.05 Volts or more negative w.r.t Ag/AgCl when measured at the end of 24 hour period

## **Inspection Criteria**

Whilst sub-sea pipeline securing assemblies are designed for long life they should be inspected on a regular basis. It is recommended that each securing assembly be inspected at the same time as routine pipeline checks, or alternatively every 24 months as a minimum. Items require replacement if they show signs of defect or wear in excess of 12%. Deterioration of GWIMP anodes and surface galvanising should also be evaluated during scheduled inspections.