Talking Safety -
- or Building Safety

Design Philosophy behind the Rotary Lifting Point (RLP)

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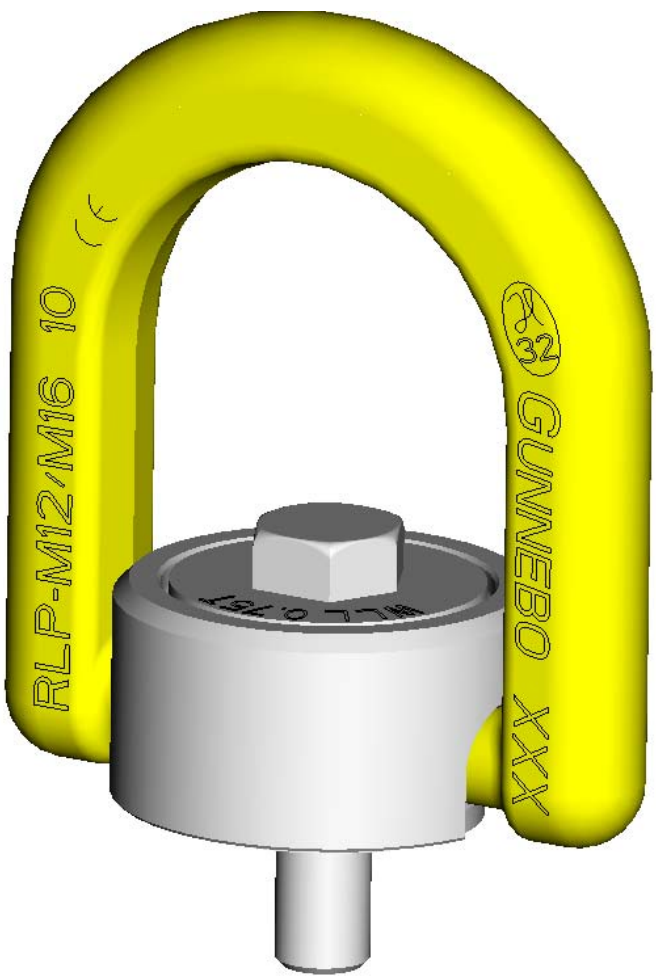


Background

In the aeronautical industry the issue of safety has always been at the top of all priorities. It applies not only to performance of single components or interaction in complete machinery systems but also in the interaction between man and machine. This wide perspective means, that the man-machinery system should have a built-in self-corrective mechanism or greatest possible "forgiveness" characteristics, in case the operator or a particular component in the system should fail.
That design philosophy has to its full extent been applied to the Gunnebo Rotary Lifting Point (RLP). The man-machine system for that product consists of three parts:
-- the RLP component
-- connected object (threaded hole area with base material and contact surface)
-- rigging operator

Primary design goal

The primary objective for improved safety with RLP (and competing products) vs the classical and problematic stiff eyebolt is therefore to reduce or completely eliminate the material stress from bending moment in the screw shaft at the screw hole entrance when lifting in any direction. This is achieved by a combination of articulating and swivelling functions for bringing down the bending moment's lever-arm to a minimum. *The less generated bending moment, the better the design.*

Secondary design goal

To compensate for the damaging bending moment due to non-ideal lifting point design, there must be a perfect shoulder contact between lifting point and base metal in order to prevent the bending moment from transfer into the screw at the hole entrance.

Risks and hazards

However**,** the perfect shoulder contact is conditional upon careful measures being taken for interaction between lifting point, base material and rigging operator. The following risks are particularly relevant:

--- insufficient *static friction* between shoulder and base metal (smoothness, surface treatment, paint, grease etc). There should be no movement between shoulder and base metal, once the screw is tightened.

--- improper hardness of *base metal*.
The base metal shall not give in or deform in any direction due to softness.

--- incorrect *angularity* (90 deg.) of supporting contact surface vs axis.
Non-perfect angularity results in extra bending stress, which can cause failure when added to the basic bending stress.

--- improper *tightening torque* applied by the rigger (from either under- or over-tightening).
This can be caused either by inevitable human error or by using incorrect tightening tools.

--- varying *dynamic friction* between static parts and turning parts when tightening (presence of grease, dust, sand or other pollution).
This will result in fluctuating axial pull in the screw from the tightening torque and varying stabilizing pressure between shoulder and base metal.

Detailed user recommendations for above factors are**,** to a varying extent**,** given by the lifting point manufacturers, but the responsibility and control, that the recommendations are applied for safe use of the lifting point and that all above risks are taken care of, is entirely down to the end user. And *the higher the damaging bending moment is, the higher is the risk of failure*, if the above hazards are not fully controlled.

Analysis and comparison of bending moment factor for some different lifting point types.

So the primary goal, to reduce the bending moment to a minimum (and thereby minimize or eliminate the secondary hazards) is key to the manufacturer's success (or failure) in designing and building a lifting point with the best possible safety properties in practical use. The ideal pulling force line, which gives no added bending moment, passes through the centre point of the thread hole entrance (=the ideal point). The lever-arm (*a*), (= right-angle distance from force line to ideal point) as the ratio of the thread diameter (*d*) is defined as the Bending Moment Factor (*BMF*) and is proportional to the bending stress generated in the screw in case it is not tightened correctly.
So by comparing different lifting point types for the BMF value with the same screw diameter and lifting force, it will give the true ranking of how effective the lifting point designs are to eliminate the creation of the damaging bending stresses in the thread. And that should be priority no 1, when replacing the classical eye bolt with articulating lifting points.

Bending moment formula:

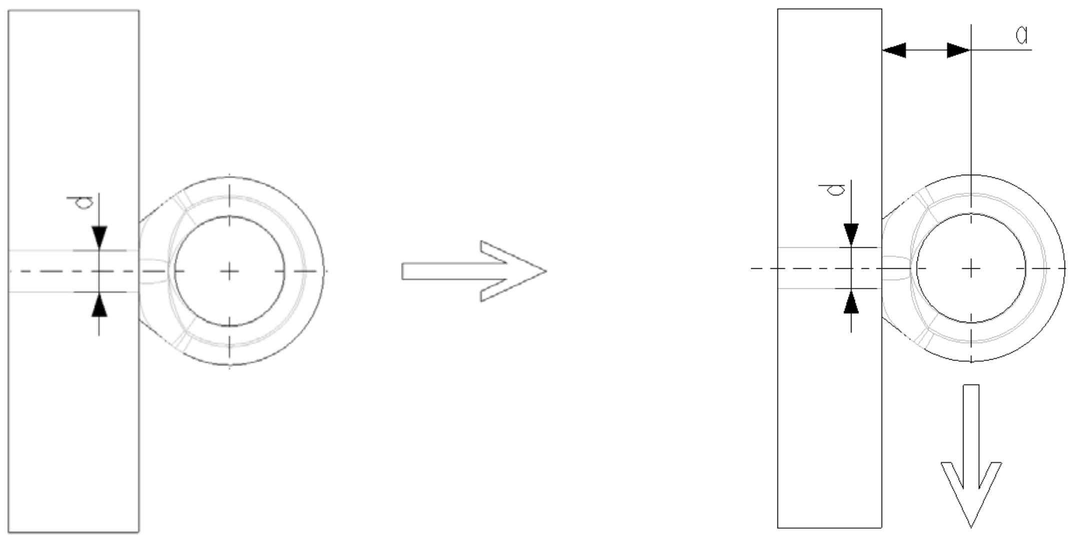
BM = bending moment, *F* = lifting force, *a* = lever-arm,
d = thread diameter, *BMF* = bending moment factor

$$BM = F \times a = F \times BMF \times d$$
$$BMF = a / d$$

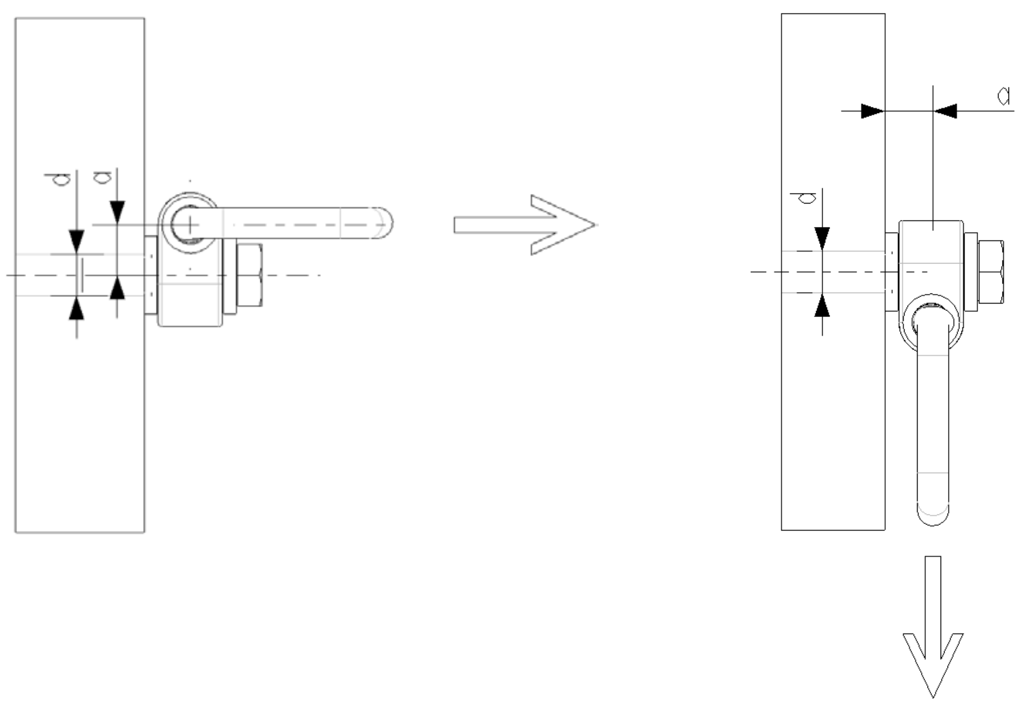
The force directions 0 deg. and 90 deg. are considered, where the maximum bending moment is generated. For DIN 580 we have analysed 90 deg., even if that is forbidden in the standard due to risk of breakage.

The following types of lifting points are being compared:

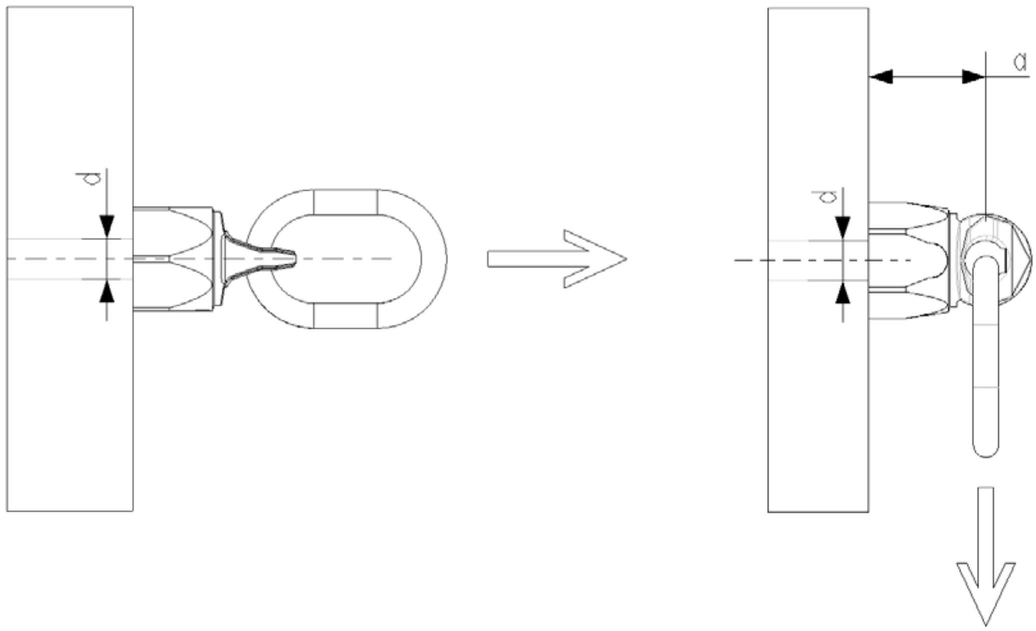
1. Classic eyebolt – DIN 580



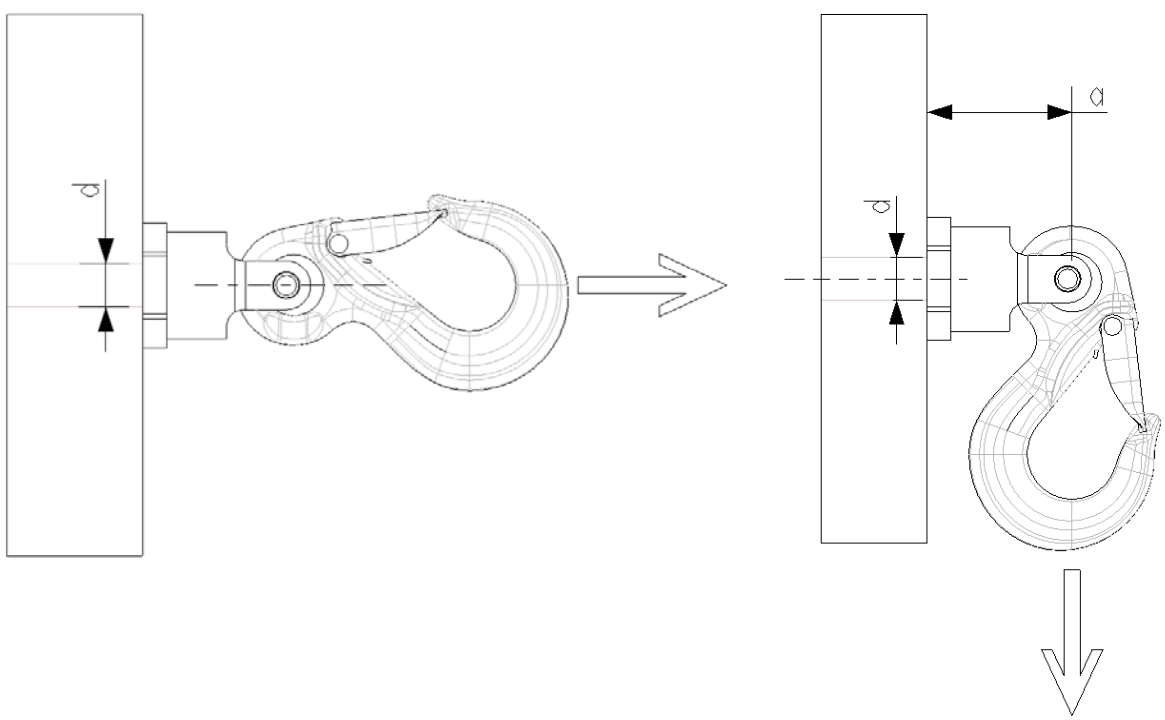
2. Off-center swivel eye link



3. Stiff swivel eye with oval link



4. Stiff swivel eye with clevis



5. RLP turning swivel open link

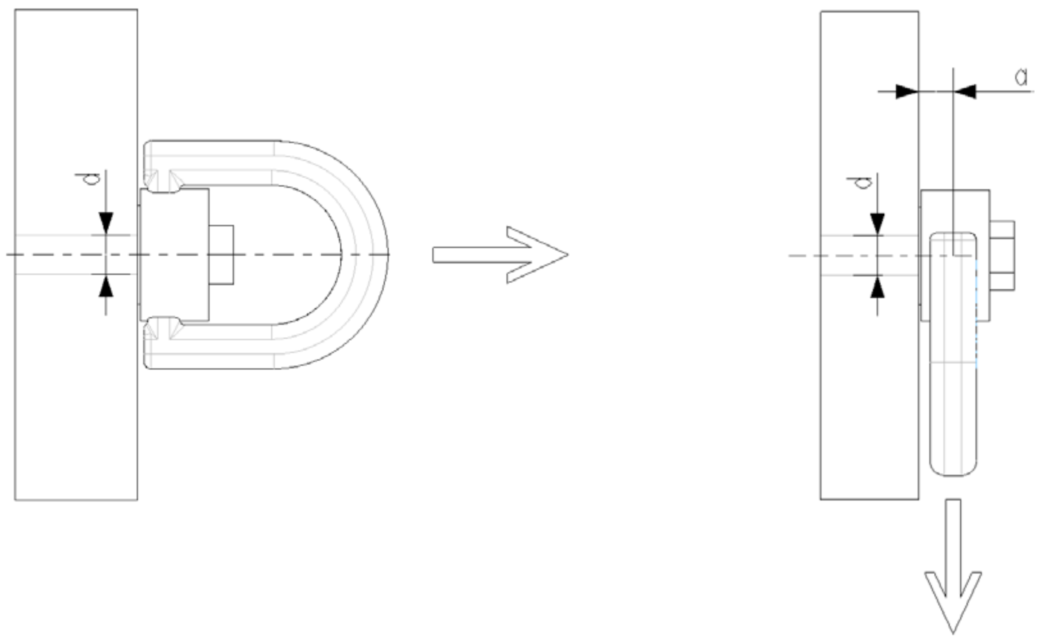


Diagram 1 shows the BMF values for the different lifting points, which directly compares between the different lifting points how much bending moment is created in an untightened screw.

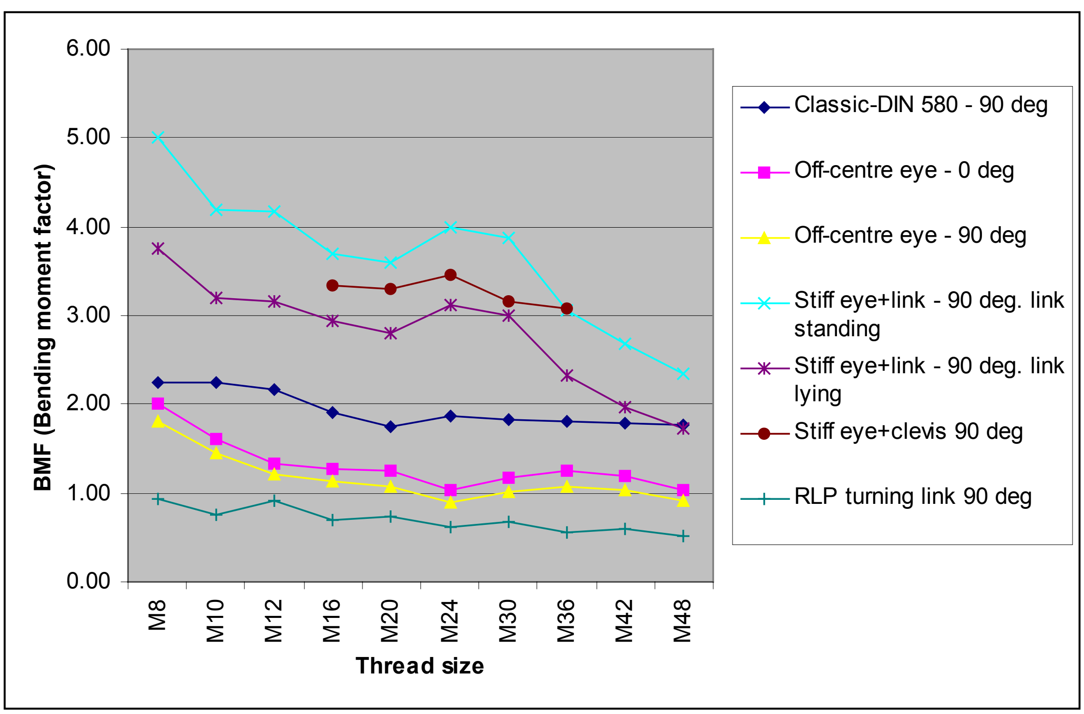


Diagram 2 shows the percentage change in bending moment compared with the classic DIN 580 (=100%).

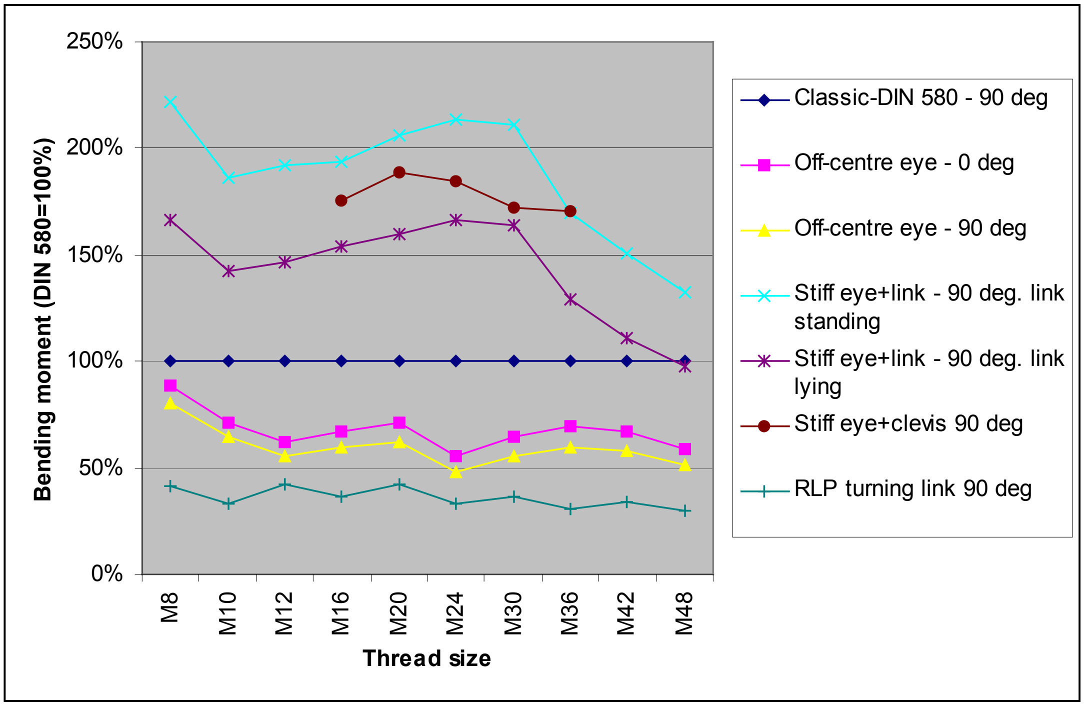
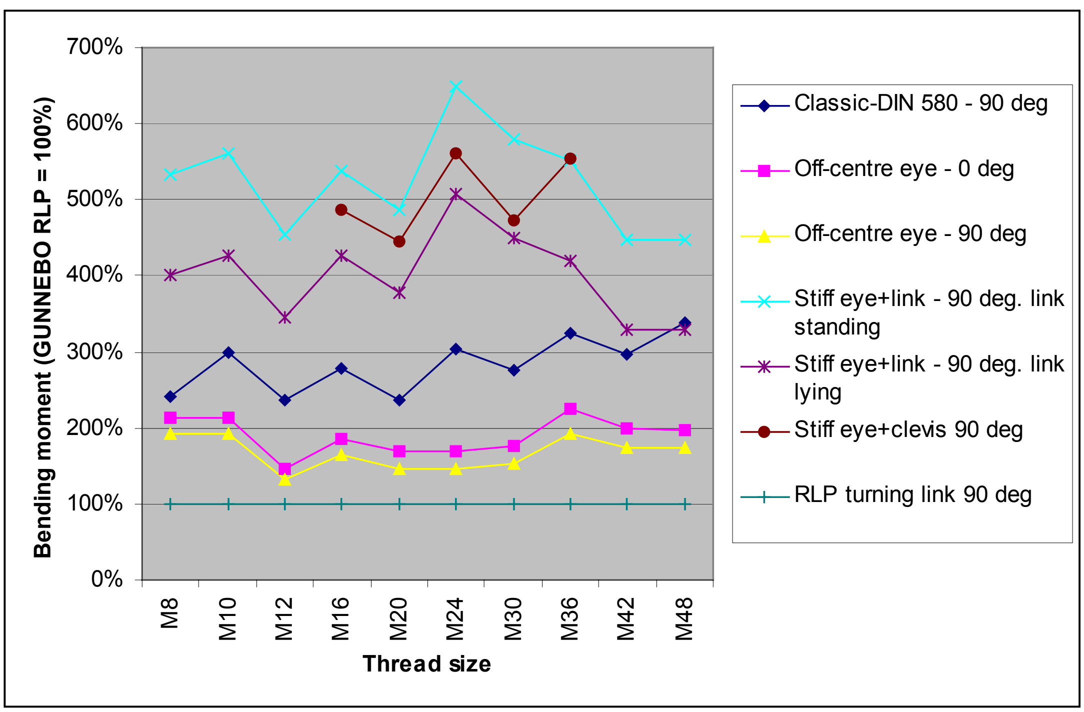
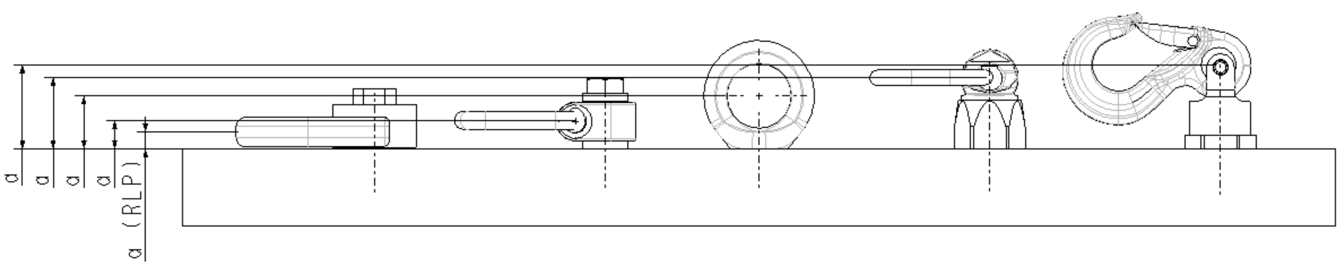


Diagram 3 shows the percentage change in bending moment compared with product with lowest bending moment RLP (=100%)



Conclusion.

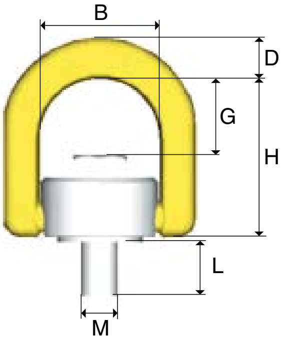
Compared to the classic eyebolt DIN 580 to be replaced with the newly developed lifting points, type 2 gives an decrease, i.e. an improvement, with appr 10 – 40 % of the damaging bending moment with improperly tightened screw; type 3 gives increase, i.e. a deterioration, with appr 30 – 120 %, type 4 gives an increase with 70 – 80 %, while type 5 - the Gunnebo RLP – gives a reduction, i.e. improvement with 60 – 70 %. RLP is at least twice as good as the second best, type 2.



So according to diagram 1 a genuinely good design for this type of product shall not have a bending moment factor – BMF - higher than 1, i.e. the lever arm shall in no direction be longer than the corresponding thread diameter. This rule of thumb is easy to check and should be applied, when products of this type are selected for installation and should be a good precaution against bent and broken bolts.

That gives the true picture of the Gunnebo philosophy, transferred from the aeronautical industry, with flight safety on top, into lifting safety products, where the consequences of a mistake, e.g. improperly tightened screw by the rigger, shall be mitigated and not worsened with the introduction of a new product.

*) Drawings and pictures show only the principal type of design and do not refer to a particular manufacturer. Dimensions are examples based on published manufacturer catalogue data.



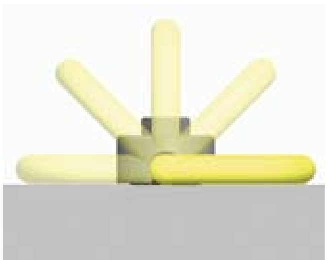
Rotating Lifting Point, RLP

Code	WLL Tonnes*	L	M	B	D	G	H	Weight kgs
RLP M8-10**	0,3	15	M8	42	12	35	60	0,3
RLP M10-10**	0,5	20	M10	42	12	34	60	0,3
RLP M12-10**	0,75	19	M12	57	19	46	85	0,9
RLP M16-10**	1,5	24	M16	57	19	44	85	0,9
RLP M20-10**	2,5	32	M20	83	28	56	111	2,8
RLP M24-10	3,5	37	M24	83	28	53	111	2,8
RLP M30-10	6	49	M30	114	34	69	144	7,0
RLP M36-10	8	61	M36	114	34	65	144	7,3
RLP M42-10	14	65	M42	149	40	90	185	14,0
RLP M48-10	16	75	M48	149	40	86	185	14,9

*Safety factor 4:1

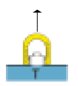
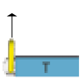
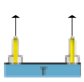
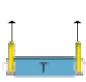
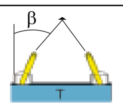
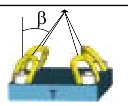
Straight pull gives a higher WLL, see table below.
Longer bolt can be supplied on special request.
**Available in UNC thread; 5/16”, 3/8”, 7/16”, 5/8”, 3/4”.

180°



360°

Working Load Limits (tonnes)

								
No. of legs	1	1	2	2	2 symmetric		3 and 4 symmetric	
β	0°	90°	0°	90°	0-45°	45-60°	0-45°	45-60°
Load factor	*)	1	*)	2	1,4	1	2,1	1,5
RLP-M 8-10	0,60	0,30	1,20	0,60	0,42	0,30	0,63	0,45
RLP-M10-10	1,00	0,50	2,00	1,00	0,70	0,50	1,05	0,75
RLP-M12-10	1,50	0,75	3,00	1,50	1,00	0,75	1,60	1,13
RLP-M16-10	3,00	1,50	6,00	3,00	2,10	1,50	3,15	2,25
RLP-M20-10	5,00	2,50	10,00	5,00	3,50	2,50	5,25	3,75
RLP-M24-10	7,00	3,50	14,00	7,00	4,90	3,50	7,35	5,25
RLP-M30-10	12,00	6,00	24,00	12,00	8,40	6,00	12,60	9,00
RLP-M36-10	14,00	8,00	28,00	16,00	11,20	8,00	16,80	12,00
RLP-M42-10	16,00	14,00	32,00	28,00	19,60	14,00	29,40	21,00
RLP-M48-10	20,00	16,00	40,00	32,00	22,40	16,00	33,60	24,00

*) Provided only axial loading takes place, i.e. no bending force applied in the direction of the thread.

RLP- Rotating Lifting Point, Grade 10

The patented new design of the RLP makes it suitable also in applications where a conventional Lifting point would not be fully adequate. Intended to be used as a Lifting point, Lashing point or Towing attachment.

- Dismountable open D-ring. Enables assembly of roundsling, master link, link or hook directly onto the RLP.
- Hexagon-headed screw for easy assembly/disassembly by means of an ordinary wrench.
- RLP can rotate 360° and articulate 180°.
- Forged in Grade 10 material permits higher WLL than Grade 8 and DIN 580 eyebolts.