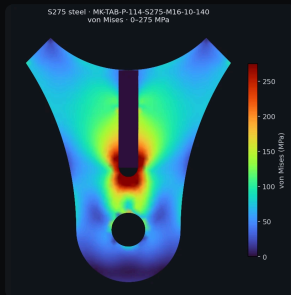
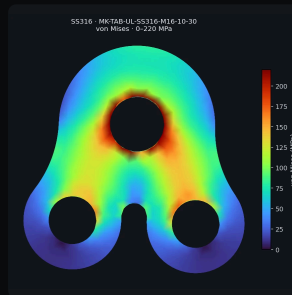


How MAKANIK FORGE checks its parts

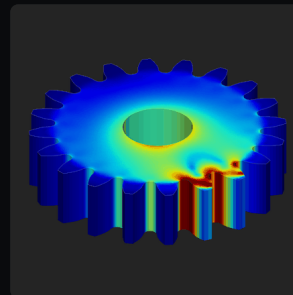
The methods, the validation and the limits behind every MAKANIK FORGE part: the rated packs and the free generators. What is checked, how we know the checks work, and what we deliberately do not claim.



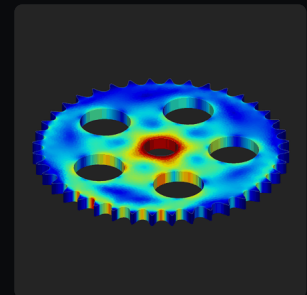
Saddle tab, rated radial pull



Bolt-on tab, rated axial pull



Spur gear, root stress



Lightened sprocket, web stress

1 Why this paper exists

A drawing file looks the same whether or not anyone checked it. This paper shows how our parts are checked, so you can decide how far to trust them.

MAKANIK FORGE generates cut-ready parts on demand: you give it a few numbers, and it returns a part with its conditions printed on the file. Four ranges, saddle tabs, weld-on tabs, bolt-on tabs and UL gussets, are sold as **rated packs**: a STEP solid, a rated drawing and an FEA report for each part number, with the flat DXF free. The spur gear and sprocket generators are free outright. Either way it is fair to ask what you are getting, and the honest answer is in the method rather than the marketing.

Chapter 3 sets out the method every rated pack shares. Each chapter after it covers one part range and answers the same four questions:

- **What is checked.** Which standard sets the geometry, and what the engine tests on every part it builds.
- **How we know the checks work.** Comparisons against textbook answers and a standard's own worked values, mesh studies, and cases where a check had to be proven able to fail.
- **Where we chose to be cautious.** Every value that is ours rather than a standard's is declared as such, and is set on the safe side.
- **What we do not claim.** The limits are as much a part of the product as the numbers.

We show the method and representative results. We do not publish every data set or every internal constant: those live in the engine, and they are re-checked every time the engine changes. Standards are cited by number and edition. Their text and tables are not reproduced here, and you should read the standard itself for anything you rely on.

This is a living document

A new chapter is added as each part range goes live, and existing chapters are revised when the method changes. The edition and date are on the cover. The newest edition is always at forge.makanik.co.za.

2	The house rules every part follows
3	How a rated pack is solved and rated
4	Saddle tabs: two directions, rated separately
5	Weld-on and bolt-on tabs: the bolt is the fuse
6	UL gussets: a truss web, and a clear weld land
7	Spur gears: true trochoid root, rated to ISO 6336 methods
8	Sprockets: ISO 606 teeth as true arcs, and the lightened web
9	What the checks changed in the parts
10	Standards cited

2 The house rules

These rules sit underneath every part range. They are enforced in code, not left to good intentions.

- **One geometry, one author.** The DXF, the STEP and the web page are all produced from the same function call. A figure on the page cannot disagree with the file, because both are read from one place. When they have disagreed in the past, it was a bug to find, never a number to adjust.
- **Round toward safety, every time.** A published rating is rounded down. A tolerance band is rounded inward, so the printed band is never wider than the real one. An amount of material to remove is rounded up. A rating of 6.69 is never printed as 6.7.
- **A refusal names the fix.** If the generator will not make a part, it says which input to change and what value would work. Refusing is the most important thing a generator does, because a free tool that quietly hands you a part it should have refused is the failure that matters.
- **Every number says where it came from.** Taken from a standard; measured on your part's own geometry; declared by us as a conservative floor; or supplied by you. Where a value is ours, the file says so, and you may raise it with evidence.
- **Leave unapplied anything that would raise a rating.** If a clause or factor would make a part look stronger and has not been verified, it is not applied. If it would make a part look weaker, it is applied now. An unverified clause costs nothing to leave out. Leaving out one that lowers a rating would cost you.
- **A guard that passes both answers is not a guard.** Every check is shown to reject the wrong answer, not only to accept the right one. Where a gate is set by measurement, the case just outside the gate is solved too, and must fail.
- **A regression check after every change.** Each generator carries a script that rebuilds hundreds of parts and re-checks them against known values. It is run after every change, on our machine and again on the web server before a new version goes live.
- **Someone else looks.** Each lane is reviewed by a reviewer who did not build it, looking for errors rather than confirming the work. Chapter 9 lists what the reviews changed.

We rate the design. You make the part.

Our checks cover the part as drawn, in the stated material, against the conditions printed on its file. Cutting, material, welding and installation are outside our control, so they do not replace checking your own application: your loads, your structure, your fixing, your machine and your material certificate. No part is for lifting or overhead life-safety use unless independently certified.

3 How a rated pack is solved and rated

Four ranges are sold as rated packs: saddle tabs, weld-on tabs, bolt-on tabs and UL gussets. Each pack is a STEP solid, a rated A4 drawing and an FEA report for one part number. This chapter is the method they share. Chapters 4 to 6 are what is particular to each.

3.1 The model

Every rating starts from a finite-element model of the exact part in the pack: the same solid, built by the same call that writes the DXF and the STEP. It is meshed in quadratic tetrahedra and solved linear-elastic at the rated load, with a linear buckling step on the same model. The restraint is the one the part sees in service, and it is printed on the drawing:

RANGE	HELD	LOADED
Saddle tab	Saddle arc and gusset base, fully fixed	Bolt hole, pulling away from the pipe
Weld-on tab	Welded base edge, fully fixed	Bolt hole, axial pull
Bolt-on tab	Both base feet, at their bolt holes	Working bolt hole, axial pull
UL gusset	One welded leg, fully fixed	The other leg, pulled so the corner opens

3.2 The rating comes from a mechanism, never from the peak

On the three tab ranges **the bolt is the fuse**. The rated load is the bolt's single-shear capacity, and the plate is built past it, so the failure you design for is the one you get. The FEA then checks that the plate really is not the weak link: the net section against the material's proof stress, bearing at the hole, and buckling. On the gusset, which has no bolt, the net section of the web governs at a factor of safety of 1.25. Every range must clear buckling by at least 1.5 times; on our free sample pack and the three example packs on the site it runs from 95 to 420 times.

The one number a rating is never read from is the peak stress at a hole or a slot. At a sharp internal corner the peak is a property of the mesh, not of the part:

MESH	NODES	PEAK VON MISES AT THE NOTCH
coarse	21 327	1 010 MPa
medium	46 267	1 064 MPa
fine	142 895	1 220 MPa

Same saddle tab, same load, three meshes. The peak keeps rising as the mesh is refined. Rating the part off it would give 5.75 kN against its true 22.27 kN. The stresses that do converge, the nominal stress across a section, are the ones the rating uses, and the peak is reported in every FEA report as a durability detail, with this table beside it, so you can see why.

3.3 One solve rates a family

For the tab ranges the rated direction does not depend on the tab's length, so one solve covers every length on the same bolt, plate and material. That is how **198 finite-element models rate 1,192 parts**. The figures that do change with length, such as a saddle tab's side rating and minimum host wall, are worked for each part number and printed on its own drawing.

1,192

part numbers on sale, each with its own pack

198

finite-element models behind them

YM2 1.25

partial factor, EN 1993 design basis

≥ 1.5

buckling factor every part must clear

3.4 A second, independent solver

Five saddle-tab models, in S275 and SS304, were translated card for card into the input format of a second, independent finite-element code and solved again: the radial case and the side load in both directions. Displacements matched to round-off. Stresses matched within 0.22%. Because the translation gives both codes exactly the same nodes, restraint and load, this checks the *solution*, not the *model*; the model is checked by the mesh studies and the closed-form comparisons in the chapters that follow. The cross-check covers the saddle-tab range today and is being extended to the others.

3.5 Nothing is published until every gate passes

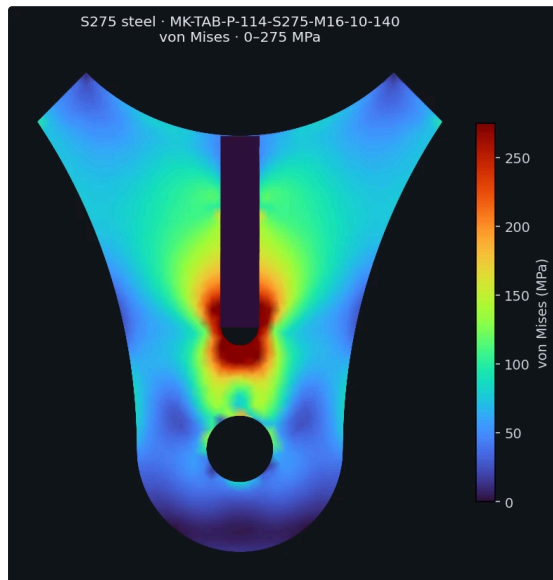
Each catalogue build runs a set of gates before a single file goes to the server. The build must be exactly the parts on sale, no more and no fewer. The rated load must be the same in the README, on the drawing and in the report. The mass on the drawing must be the mass of the solid. Every STEP body carries its part number. Every DXF is plain text with arcs and lines only. Every drawing is audited for legibility: no dimension off the sheet, on the part, on another dimension or across a load arrow. If any gate fails, nothing is uploaded.

Materials

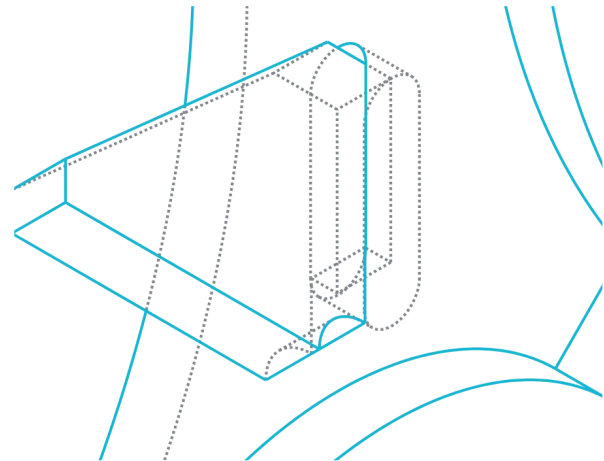
Steel S275 to EN 10025-2; stainless 1.4301 (304) and 1.4401 (316) to EN 10088-2; aluminium 6082-T6, 7075 and 2024. Each is rated at its minimum proof stress. Welded aluminium is rated at its **heat-affected** proof stress, 125 MPa for 6082-T6, not at the parent metal's, because a weld softens the metal beside it.

4 Saddle tabs

A bolt tab whose base is cut to the pipe's outside diameter, braced by a gusset keyed through a slot in the fin. S275 on nine pipe sizes from 26.9 to 114.3 mm, SS304 on six. M6 to M16. 402 part numbers from 57 models.



MK-TAB-P-114-S275-M16-10-140 at its rated 60.28 kN, scale 0 to 275 MPa (the proof stress, not the peak). The bolt is the fuse; the plate is not the weak link.



The gusset's tongue drops into a slot cut through the fin, plate thickness plus 0.3 mm, so the gusset locates itself while you tack it.

4.1 Two directions, rated separately

F1 is the radial pull away from the pipe, and the bolt in single shear sets it. **F2** is a push perpendicular to the fin, into the gusset, and it is much smaller: on our free sample pack, 2.93 kN against F1's 22.27 kN. Both are drawn on the sheet as labelled arrows from the bolt centre, with the same labels on the rating rows, because a rating whose direction you cannot find on the drawing is not much of a rating. An off-axis pull is resolved into F1 and F2, and each must be met.

F2 is set by the fin bending out of plane above the gusset. It is worked from a closed-form chain for each part number, and the chain was checked against FEA at the critical section on 63 models: the FEA reads 1.04 to 1.19 times the closed form, median 1.13. A knockdown of 1.20 is applied, which covers the worst case measured. It is a measurement, not a safety factor, and it is re-measured if the geometry changes.

4.2 A second gusset: same number, both directions

A second gusset, the same profile turned over onto the other face, is an option on the same part number. It does not raise F2, because it does not raise the height at which the fin is braced. What it buys is direction: the assembly is mirror-symmetric about the fin, so F2 then applies both ways at the same value. We solved it to confirm: the second gusset changed the stress at the critical section by 0.05%.

4.3 Sized the way you set it out

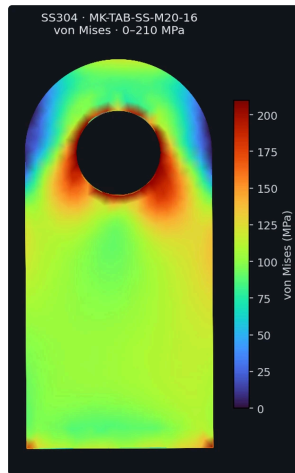
- **The part number is the reach.** Its last field is the distance from the bolt centre to the pipe axis, in round 5 mm steps, which is the dimension a designer works from. The height above the crown is printed in brackets as a reference.
- **Minimum host wall, on the wall you measure.** Each part number states the thinnest pipe wall it is rated on, rounded up. The tube standards allow a wall to run under nominal: EN 10219-2 and EN 10210-2 by 10%, EN 10255 by 10% welded and 12.5% seamless, EN ISO 1127 by 7.5% to 15% by class. So a nominal 5.0 mm pipe can be a compliant 4.25 mm. Work to the standard your pipe is made to, or measure it.
- **Stainless sits on stainless sizes.** The SS304 range is offered only on outside diameters that stainless pipe and tube are actually made in, so the saddle seats with the root gap the drawing states.
- **Welds as rated.** The saddle weld is checked against the rated load, and the drawing carries the leg and the root gap the part was rated with.

4.4 What is not claimed

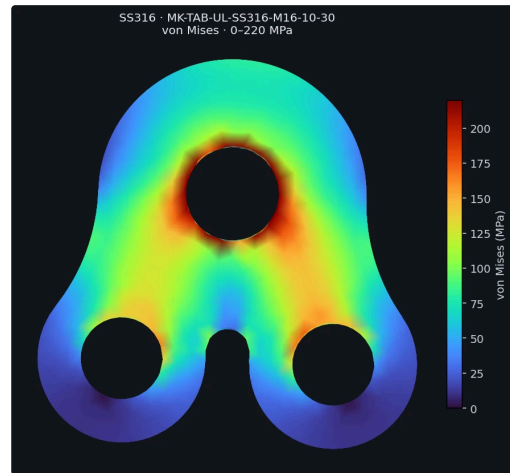
- Pulling **away from the gusset**, or across the fin, is not rated.
- In service it is usually the **fitting** that limits F2, not the tab: shackles are de-rated or prohibited in side load. The drawing says so beside the number.
- **The host pipe** is your structure and your check.
- Static loads only. Not for lifting or overhead life-safety unless independently certified.

5 Weld-on and bolt-on tabs

Two ways to make a bolt point: weld a flat tab to your structure, or bolt an optimised one down with no heat at all. Both are rated in axial pull, and in both the bolt is the fuse.



Weld-on MK-TAB-SS-M20-16 at its rated 82.32 kN, scale 0 to 210 MPa (SS304 proof). Base edge fixed, bolt hole pulling away.



Bolt-on MK-TAB-UL-SS316-M16-10 at its rated 52.75 kN, scale 0 to 220 MPa (SS316 proof). Two base feet fixed; the load spreads round the collars.

5.1 Weld-on tabs

A flat tab with a semicircular head, in S275, SS304 and 6082-T6 aluminium, M3 to M20. 585 part numbers from 57 models. The width is solved for each bolt and plate so the plate develops the bolt: when the bolt reaches its shear capacity, the net section is still below the material's proof stress (on the SS304 M20, by 1.06 times). The margin is in the bolt, not in a heavier plate, and the drawing states that in words. The plate must also resist the bolt pulling out through it, by at least 1.1 times.

Every bolt size is offered on more than one plate. A thinner plate is widened until it still develops the full bolt rating, so you can choose by load or by the plate you already have.

5.2 Bolt-on tabs

Two base feet, a swept collar and a lightening slot up the centre: the material comes out along the load path, where the analysis shows it is not working. SS316, 7075 and 2024, M6 to M20. 139 part numbers from 18 models. The net section keeps a factor of safety of at least 1.25 to proof, and the two base bolts together must carry at least 1.1 times the rated load.

- **The length is between bolt centres**, base bolt to load bolt, the same figure the part number ends in. It steps in 5 mm.
- **Both bolt heads fit**. Every length is checked for washer clearance between the load bolt and the base bolts before it is offered.
- **The geometry is checked against the CAD it came from**. The engine's solid matches the mass of the original CAD masters within 0.1 to 1.8% across M6, M12 and M20 at fourteen lengths.

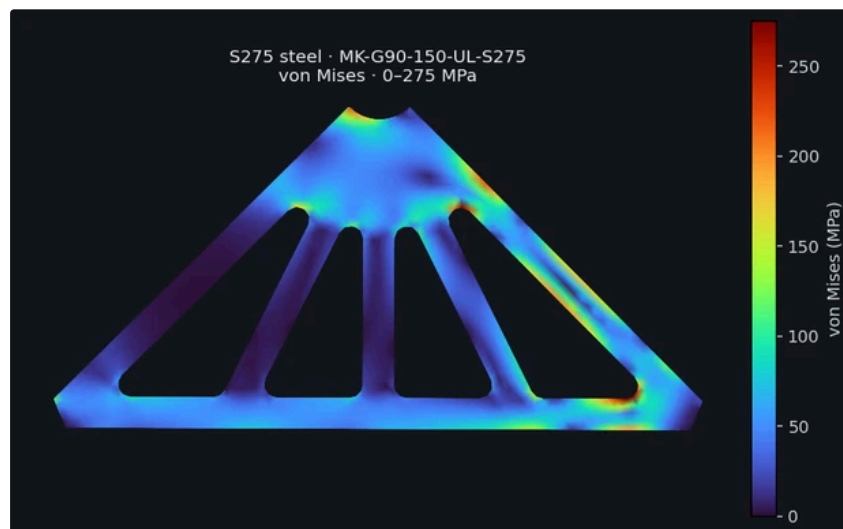
5.3 What is not claimed

- **The weld on a weld-on tab** is specified on the drawing as a continuous fillet both sides, and the base is modelled as fully fixed. The weld's own strength is not part of the rating. Welding, and for aluminium the welding procedure, are yours.
- **The structure** the tab is welded or bolted to is your check, as are the base bolts' preload and the surface they clamp.
- Axial pull only, static. Side and twisting loads are not rated. Not for lifting or overhead life-safety unless independently certified.

CHAPTER 6 · UL GUSSETS

6 UL gussets

A corner gusset whose solid web is replaced by a truss, sized against the material's own proof stress. Rated at 45°, 60°, 90° and 120°, legs 50 to 200 mm, in S275 and SS304, and on a narrower range in 6082-T6 aluminium. 66 part numbers, each solved on its own.



MK-G90-150-UL-S275 at its rated 10.50 kN corner-opening load, scale 0 to 275 MPa. One leg fixed, the other pulled. The truss carries the load round the web and the members run cool.

6.1 What is checked

The rating is for one stated case, the corner opening: one welded leg fixed and an in-plane pull on the other. The net section governs at a factor of safety of 1.25, and buckling must clear 1.5. The truss members are sized for each material, so the aluminium gusset is not the steel one in a lighter metal: its members are wider, in proportion to its lower proof stress.

- **Plate from the leg, not from a table.** Thickness follows the band $L/20$ to $L/5$ of the leg, snapped to the nearest stock plate, and the drawing prints the band.
- **A clear weld land in the corner.** Every truss opening is kept at least 1.0 mm clear of the inner cove, measured on the cut outline, so the weld at the root of the corner always has solid plate to land on.
- **The cove is sized for the weld.** The drawing states the largest fillet the cove clears, and says not to fill it.
- **A size ladder that reads honestly.** On the same plate, a longer leg is a longer lever on the web, so it can rate lower than the size below it. It reaches further and welds longer; it does not carry more. Our size

matrix shows the plate under each leg and marks where that happens, rather than letting a bigger part number suggest a bigger load.

6.2 What is not claimed

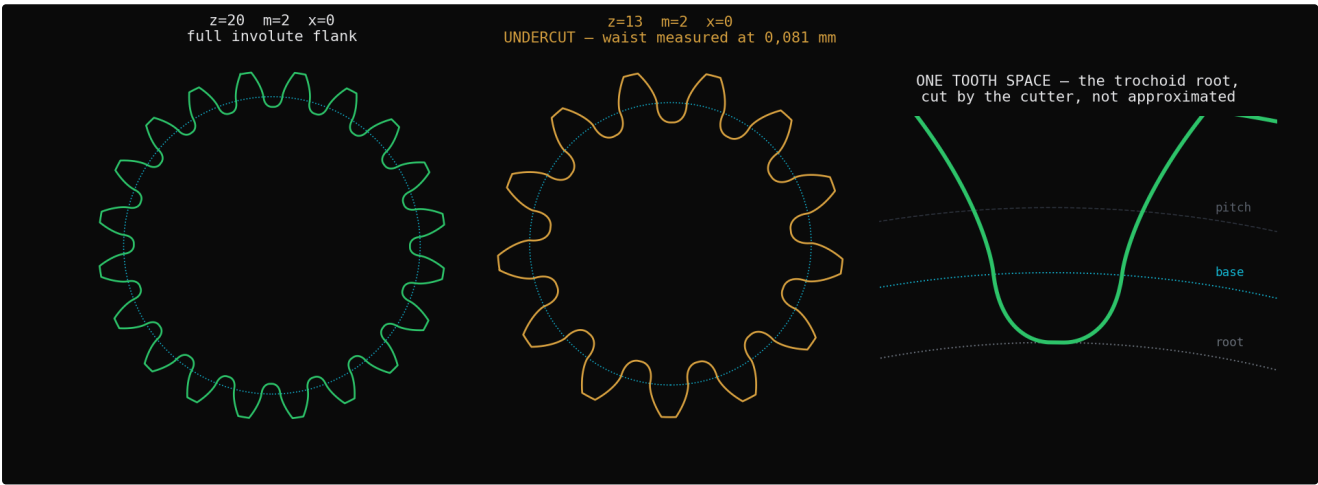
- Only the corner-opening case is rated. Closing, twisting and out-of-plane loads are not.
- **The welds** are specified on the drawing at 0.7 t both sides. Their own strength is not part of the rating, and for aluminium the fillet size must be confirmed by your welding procedure.
- The solid gusset's flat DXF is free and carries geometry only. The rating belongs to the UL truss in the paid pack.
- Static loads only. Not for lifting or overhead life-safety unless independently certified.

7 Spur gears

External spur gears cut from flat plate, identified from a gear in your hand (outside diameter, tooth count, plate thickness) and rated in root bending and in pitting.

7.1 Geometry: rolling the cutter, not drawing an arc

Most free generators draw the tooth root as a circular arc. The root is exactly where a gear tooth breaks, so an approximate fillet makes any torque figure meaningless. Our engine rolls the standard basic rack past the blank and takes the envelope of every position. The involute flank and the **true trochoidal root** come out of that process on their own, with nothing fitted. Undercut on low tooth counts also appears on its own rather than being a special case.



Left: $z = 20$, $m = 2$, full involute flank. Centre: $z = 13$, where the rack cuts into the flank (undercut) and the engine measures the waist. Right: one tooth space, showing the trochoid root as the cutter leaves it.

We validated the generated profile against textbook values, not against itself:

1 μm tooth thickness against the textbook value	0.3 μm involute flank against the analytic curve	exact root and tip radii	17 vs 17.1 undercut onset, generated vs theory
---	--	------------------------------------	--

7.2 Rating: worked to ISO 6336 methods

Every gear carries a torque rating in two failure modes: root bending (ISO 6336-3) and surface pitting (ISO 6336-2), with the load factors from ISO 6336-1 and the material from ISO 6336-5. **The lower of the two modes is the one published.** Two service classes are rated:

CLASS	WHAT IT MEANS	WHAT USUALLY GOVERNS
Intermittent	Up to 10^4 load cycles: positioning, occasional drives, hand-operated mechanisms	Pitting on most of the range; bending on high tooth counts
Continuous	Long life, 10^{10} cycles	Pitting

The speed rating follows the cut process you choose (laser, waterjet, wire EDM, hobbed or shaped), because the accuracy of the cut and the finish of the flank are what set the dynamic load. A thermally cut tooth is rated at the ISO 9013 roughness for its plate thickness, on a tooth thinned to the edge of the cut

tolerance. In our study of the reference gear, having it hobbled instead of laser-cut roughly doubled its speed ceiling. That is a real engineering choice, and you can only make it if someone shows you both answers.

Every factor carries a tag

Where ISO leaves a value to the designer, or where the true value depends on your installation, we declare a floor. Each is tagged on the derivation, and each sits on the safe side:

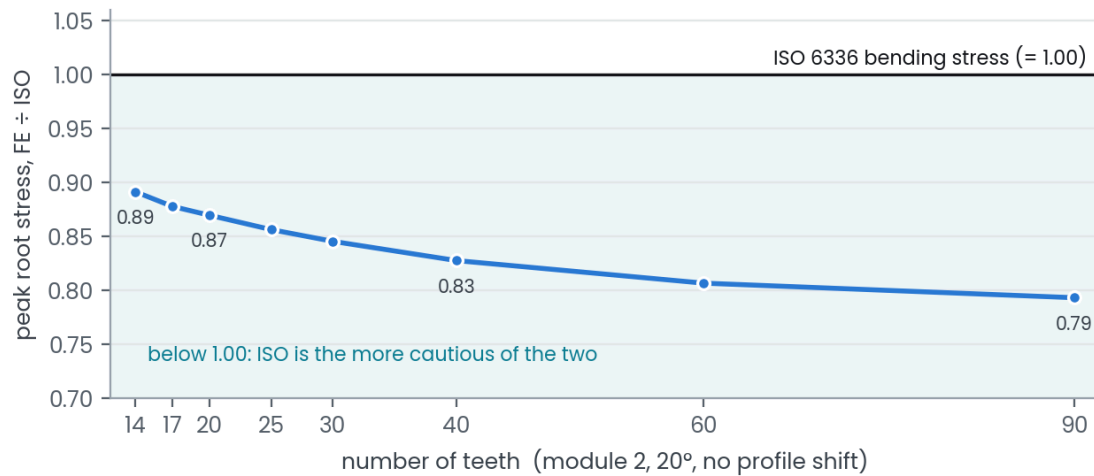
DECLARED VALUE	WHY IT IS CAUTIOUS
Face load factor DECLARED	It depends on your shaft deflection and mounting, which we cannot see, so a firm value is declared. Only a stated mounting may lower it.
Material DECLARED	Structural plate is rated at the floor of the standard's own lowest steel class. It needs no certificate and cannot over-promise.
Flank and root roughness DECLARED	Set per process, on the rough side. A shop may raise it with a roughness measured on the fillet, not a machine brochure.
Lubricant and life factors DECLARED	Lowest validated oil grade; a long-life factor below 1.0 for continuous duty.
Application factor YOURS	Shock and duty are yours to state. The default is 1.00, and the file prints it.

The honest reading

A soft steel plate gear is, by ISO 6336, a low-duty part. The flank factors enter the pitting calculation squared, so the declared floors weigh heavily. On the reference gear in our study, raising four floors together (oil grade, cut process, hardness, life factor) raised the continuous rating about fivefold. The route to real continuous torque is a harder material, and the generator says so rather than hiding the number. That is why intermittent duty is the headline, with continuous shown beside it.

7.3 Checking the method itself

ISO's bending method estimates the root stress with tooth-form and notch factors. We checked it against our own finite-element model of the tooth root, built on the same generated trochoid. The model applies the tooth load along the true line of action and reads the stress at the section ISO rates. We ran the check from 14 to 90 teeth:



Peak root stress from the finite-element model divided by the ISO 6336 bending stress, $m = 2$, $x = 0$. Every point sits below 1.00: at every tooth count we solved, ISO is the more cautious of the two. We publish on ISO, not on our model.

±0.32%

same model on two different machines

≤0.25%

shift from halving the mesh size, at every tooth count

6 figures

result unchanged from module 1 to module 10

14 to 90

tooth counts solved, trend smooth and monotone

How the model earned that chart. Its first runs disagreed with ISO by up to 18% and zig-zagged with tooth count. We did not tune it until it agreed. We found three defects: the tooth centreline was read off a discretised tip, the sampling band never reached the section ISO rates, and the load was not applied along the line of action. With all three fixed, and the two calculations sharing one definition of the root and one load line, the curve became smooth and monotone with nothing fitted.

Where ISO stops being cautious, and how far away we stay

Pushing the check across profile shift found a corner where ISO's method *under*-predicts the root stress: deeply undercut teeth with a negative shift. The crossing lines up with a single parameter, the notch ratio of the critical section, at a value of about 1.00 across three tooth counts. The generator already refuses every one of those cases through its undercut rule. The closest a gear it will publish can get sits 63% clear of the crossing.

7.4 What the generator refuses

Undercut; pointed tips; a gear thicker than its own pitch diameter; a disc too thin not to dish; a module finer than the cut process can enter; a plate thicker than the machine takes; a gear wider than the stock sheet; a profile shift beyond the range the rating method holds for. Each refusal names the input to change and the value that would work.

7.5 What is not claimed

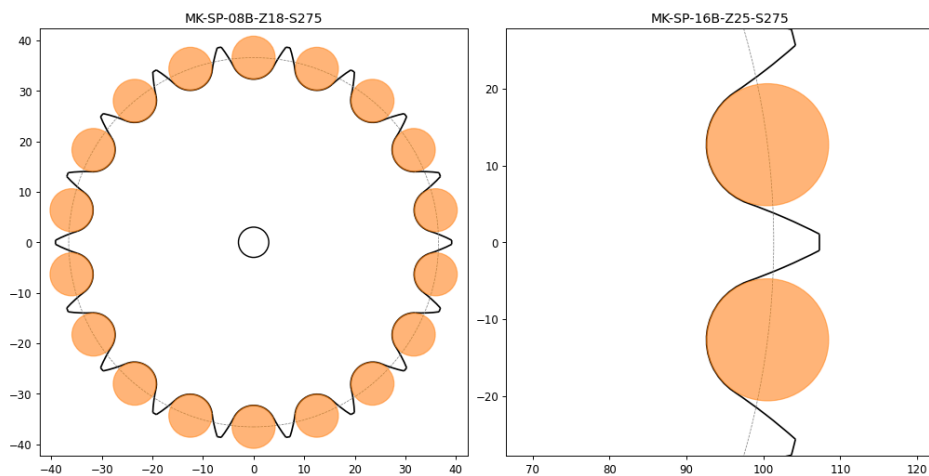
- It rates **one gear's teeth** against an identical mate. It is not a gearbox rating, a shaft check or a bearing check.
- A **form-milled** gear (a single-tooth cutter) has the cutter's root, not the trochoid in the file. The cutting tables still apply. The torque does not.
- The rating holds only under the conditions printed on the file.
- The gear generator issues **DXF** today.

8 Sprockets

Plate sprockets for ISO 606 B-series simplex roller chain, 06B to 72B, 9 to 150 teeth. Structural plate or hardened wear plate. Solid, or with lightening holes where the web has been checked. DXF and STEP.

8.1 The tooth, as true arcs

ISO 606:2015 does not fix one tooth shape. It sets a band of permitted gap forms between a minimum and a maximum. We build the middle of that band from **true arcs**: a seating arc and two flank arcs for each gap, and a tip arc on each tooth. There are no splines and no polylines, so the file cuts cleanly on older controllers and imports as clean cylindrical faces in CAD.



Chain rollers seated in generated sprockets. Left: 08B, 18 teeth. Right: one gap of 16B, 25 teeth, close up. Each roller sits in its seat on the pitch circle, touching the seat arc, with the flanks clear.

Every sprocket checks itself as it is built, and refuses to build if any check fails: the outline closes; every arc joins its neighbour tangentially; each flank is convex; the chordal pitch equals the chain pitch; the root sits on ISO's root diameter; and the measurement over pins, taken from the built outline, equals ISO's formula for even and odd tooth counts.

69

pitch-diameter values
matched to ISO 606's own
worked table

1,988

sprockets built and checked:
every chain, every tooth count

1e-10

STEP solid volume against an
independent CAD kernel

arcs only

on the cut layer, DXF and STEP
alike

8.2 Choices that are ours, declared on the file

- **Root anchored on ISO's root diameter.** The seat is placed so a seated roller sits exactly on the pitch circle. This puts the seat's centre a fraction outside the pitch circle, and the file states by how much.
- **Maximum bore** leaves one chain pitch of plate under the root. ISO 606 is silent on this. Where the largest bore would be too small to be useful, the sprocket is refused: it needs a hub, which this lane does not yet make.
- **Acceptance by measurement over pins.** Use gauge pins of the roller diameter. A chain's own rollers read low.

8.3 Plate, grinding and flatness

Every sprocket has ISO 606's tooth width, which is rarely a stock plate thickness. The file therefore names the plate to buy and the band to grind both faces into:

- **The blank is chosen under EN 10029.** Class A is the thickness tolerance you get on any order unless you ask for another. The file picks the thinnest stock whose class A minimum still reaches the tooth-width band with clean-up on both faces, so there is nothing to measure before buying. Where a thinner plate works in class B or C, the file offers it and names the class to order.
- **Grind both faces flat and parallel** into the tooth-width band. The band is printed rounded inward, and the file prints the most material the grinder may remove.
- **Flatness** is held to half of ISO 606's axial run-out allowance per face. The other half is left for the bore being square to the face.
- **Plate bow.** EN 10029 allows as-rolled plate a measurable bow over a sprocket's diameter, more for hardened plate than for structural. The file estimates it for your part and prints it when it matters, so the grinding allowance is not a surprise.
- **Hardened plate is waterjet only.** On a sprocket the cut edge is the flank the roller wears on, and a laser's heat softens it. Hardness is taken as supplied on your mill certificate. We make no engineering claim for it.

8.4 Lightning holes: offered only where they have been checked

On larger sprockets, a ring of round holes saves a lot of steel. The claim is narrow and static: **with the bore cut to its maximum, the web does not yield at the load that breaks the chain.** The chain fails first, whatever the drive asks of it.

Method. A plane-stress finite-element model of the web, with the plate at the thin end of its ground band. The chain's minimum breaking load is applied at the pitch radius over a 120° wrap, the smallest arc of contact on a driver and so the most concentrated load a correctly laid-out drive applies. The bore is clamped at its maximum. The teeth are left out, which is conservative, because they stiffen the rim. Allowable stress is the plate's minimum yield strength for its thickness under EN 10025-2. Hardened plate is not credited with its extra strength. The breaking load is a design load only and is printed on no file.

0.04%

model against the textbook
torsion answer for a solid disc

834

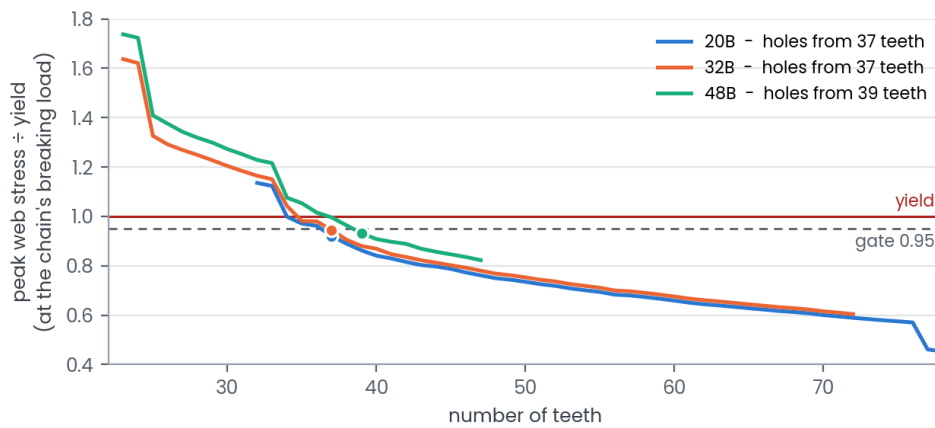
sprockets swept, every chain
and tooth count big enough to
consider

≈2%

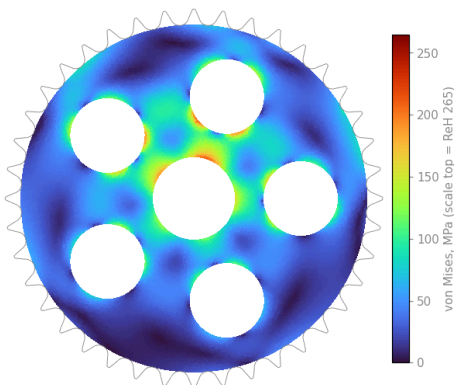
sweep mesh below the
converged peak, so the gate
sits at 0.95 of yield

both sides

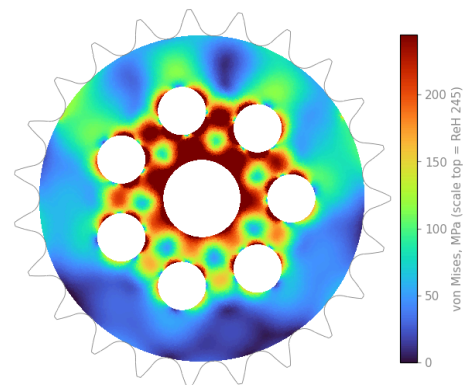
each gate passes at its tooth
count and fails one below



Peak web stress at the chain's breaking load, as a fraction of yield, against tooth count, for three of the chains. Stress rises as the tooth count falls, because less plate shares the same torque. Holes are offered from the first tooth count where every larger sprocket stays under the gate.



16B, 40 teeth: offered. Peak web stress 0.77 of yield, with the plate ground to the thin end of its band. The colour scale tops out at yield.



72B, 23 teeth: refused. The hub ring is past yield, about twice over. Even with no holes this sprocket reaches 1.5 times yield at ISO tooth width.

The 72B case is why the gate is measured rather than guessed. For small chains, holes are limited by size long before stress matters. From 20B upward, stress sets the gate. The three largest chains never pass inside the largest sheet we cut. At ISO tooth width, a flat plate sprocket for a big chain at a low tooth count is not stronger than its chain, lightened or not. Real sprockets of that size have hubs, and the generator says so rather than offering holes it cannot support.

Mesh study. On one sprocket, the mesh was refined three times. The peak rose from 0.597 to 0.610 of yield and settled. The sweep mesh reads about 2% below the converged value, so the gate is set at 0.95 rather than 1.00, which keeps the converged peak under yield.

8.5 What is not claimed

- **No drive rating and no speed rating.** In a roller chain drive the chain governs. Use the chain maker's power table or the ISO 10823 selection method.
- **No fatigue life.** The lightened claim is static, and it is stated at the chain's breaking load. A chain's working load is a small fraction of that.
- On an unlightened sprocket, the plate's own strength is not checked, and the file says so.
- **No credit for hardened plate's strength.** It is checked at the structural figure.
- Simplex B-series only for now. A-series chains, hubs and keyways are planned, and each will be checked before it is offered.

9 What the checks changed in the parts

Every range is reviewed by someone who did not build it, and every pack passes the build gates before it goes live. A review is only worth having if it is allowed to change something. These are the changes they made to what you download.

Saddle tabs

- **A second direction, rated.** The side load into the gusset, F2, is worked for every part number and printed beside F1, with its own arrow.
- **Load arrows you can read.** F1 and F2 are drawn from the bolt centre, and every dimension is now placed clear of them. Every sheet is audited for it.
- **The part number is the reach to the pipe axis**, in round 5 mm steps, matching how the part is set out in CAD and on site.
- **The minimum host wall rounds up**, and states that it is the measured wall, naming the tube standards that allow a wall to run under nominal.
- **Stainless tabs sit on stainless sizes**, so the saddle seats with the root gap the drawing states.
- **The double gusset was proven, not assumed:** same F2, both directions, by symmetry and by a solve.

Weld-on and bolt-on tabs

- **The bolt-on length is between bolt centres**, base bolt to load bolt, the dimension a designer needs and the one the part number ends in.
- **Every rating rounds down** at the precision it is printed, on the sheet and on the sizer page alike.
- **The design basis is named on every sheet:** EN 1993-1-1 and 1-8 for steel, EN 1993-1-4 for stainless.

UL gussets

- **A guaranteed weld land.** The truss openings are clipped at least 1.0 mm clear of the inner cove, so the corner weld always lands on solid plate.
- **The cove states the fillet it clears**, in millimetres, so the welder has a number to work to.
- **The size matrix shows plate thickness** and marks where a longer leg rates lower, so a bigger part number never reads as a bigger load.
- **Every rating on the site is read from the solved pack.** The page computes none of its own.

Every pack

- **One source for every figure.** The README, the drawing and the report are written from the same values, and the build checks that they agree, mass included.
- **STEP bodies carry part numbers.** Open the solid in CAD and the tab, plate and gusset are named as the parts you order, with MAKANIK FORGE as the author.
- **The buckling figure is the lowest positive mode**, the one that answers the question a buckling check asks.

Spur gears

- **Every published figure passes through one function that rounds down.** A 6.6895 N·m gear is printed 6.68, never 6.7.
- **The speed limit is set first**, then the torque is rated at the speed actually printed.
- **The rating sheet and the DXF are written from one call**, so they cannot disagree.
- **The bore limit is a real refusal**, not a note.
- **Every proof on the sheet is an independent check.** One that could not be made independent was withdrawn rather than reworded.

Sprockets

- **Lightening gates judged at the thin end of the ground band**, the plate a customer may actually end up with. Three chains moved up by one or two teeth.
- **Small sprockets whose pilot hole would exceed the maximum bore** are refused, with the tooth count that works.
- **Acceptance names gauge pins** of the roller diameter, not the chain's own rollers.
- **Plate flatness is on the file:** the EN 10029 bow estimate for your part, so the grinding allowance is no surprise.
- **Unlightened files say plainly** that the plate's own strength is not checked.
- **The deployment stops** if a regression check fails.

10 Standards cited

These standards are cited, not reproduced. Consult the standard itself for any value you rely on.

STANDARD	USED FOR
ISO 6336-1:2019	Gear load capacity: basic principles and load factors
ISO 6336-2:2019	Surface durability (pitting)
ISO 6336-3:2019	Tooth bending strength
ISO 6336-5:2016	Strength and quality of materials
ISO 1328-1:2013	Gear accuracy classes, for the speed rating per cut process
ISO 606:2015	Roller chains and sprockets: sprocket tooth form, diameters, tooth width, bore and run-out
ISO 10823	Chain drive selection. Referred to; the sprocket lane publishes no drive rating.
ISO 9013	Thermal cutting: cut-edge quality and roughness
ISO 286-2	Limits and fits: tooth-width band (h14), root tolerance (IT11), bore (H8)
EN 10029:2010	Hot-rolled steel plate: thickness classes and flatness
EN 10025-2:2019	Structural steel S275: grade and minimum yield strength by thickness
EN 10088-2	Stainless steel plate: 1.4301 (304) and 1.4401 (316)
EN 573	Aluminium alloy designation: 6082-T6
EN 1993-1-1	Steel structures: general rules and the partial factor basis
EN 1993-1-4	Steel structures: stainless steels
EN 1993-1-8	Design of joints: bolts in shear, bearing, edge distances, the saddle weld
EN 1999-1-1	Aluminium structures, including the heat-affected zone of a weld
ISO 273	Clearance holes for bolts
ISO 3506-1	Stainless steel bolts: property class A4-70
ISO 2768-1	General tolerances on the drawings
EN ISO 9445 / EN ISO 18286	Plate thickness tolerances, stainless and hot-rolled
EN 10219-2:2019	Cold-formed welded hollow sections: wall tolerance (saddle-tab host)
EN 10210-2:2006	Hot-finished hollow sections: wall tolerance (saddle-tab host)
EN 10255:2004	Steel tubes for welding and threading: wall tolerance (saddle-tab host)
EN ISO 1127:1996	Stainless steel tubes: dimensions and wall tolerance (saddle-tab host)

Our own methods (the rated-pack load cases and gates, the F2 chain, the rolled-cutter geometry, the finite-element checks and the sweep that sets each lightening gate) are described in this paper and kept as dated records with their data. The software used to solve them is not named here. What matters is the validation: each is checked against a known answer before it is used.

MAKANIK FORGE

Try it on a part you have in your hand

The flat DXF is free in every range, with no sign-up. Spur gears and sprockets are free outright. A rated pack adds the STEP solid, the rated drawing and the FEA report. Every file carries its conditions, and the generator tells you when it will not make something and why.

forge.makanik.co.za

saddle tabs · weld-on and bolt-on tabs · UL gussets · gear-generator · sprocket-generator

MAKANIK FORGE · How MAKANIK FORGE checks its parts · Edition 2, October 2026 · Chapters: rated packs, saddle tabs, weld-on and bolt-on tabs, UL gussets, spur gears, sprockets.

Ratings and checks apply to the part as generated, under the conditions printed on its file. They are not a substitute for checking your own application. Standards are the property of their publishers and are cited, not reproduced.