How to add a bolt in Advance Steel Management Tools

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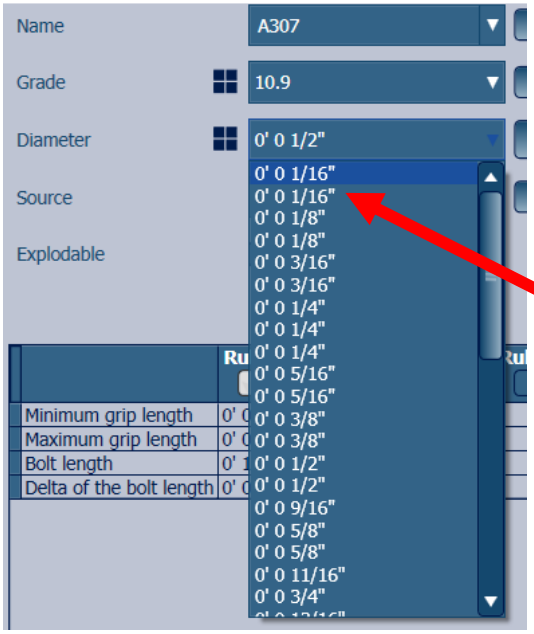
The purpose of this paper is to add 3/8” diameter bolts to the A307 set of hardware. This is especially useful for the stair macro when bolting treads to stringers, as the majority of endplates on stair treads are manufactured with 7/16” holes/slots for 3/8” hardware.

First some background on A307, A325, A563, F36 and grades. An A325 structural bolt is not made smaller than 1/2". There is no such thing as a 3/8” A325 bolt. But some A307 bolts do include 3/8” along with 1/4” and 5/16”. There are two groups of A307, 1) *Finished Hex Head Bolts* and 2) *Heavy Hex Bolts*. The A307 *Finished Hex Head Bolts* have smaller “standard” head sizes (for example 1/2” bolt is 3/4” across the flats) and include 3/8”, 1/4” and 5/16”. The A307 *Heavy Hex Bolts* have slightly larger heads and DO NOT include 3/8”, 1/4” and 5/16”. The larger heads on A307 *Heavy Hex Bolts* (1/2” bolt is 7/8” across the flats) are the same wrench size as A325 bolts. The group of A307 bolts already installed in Advance Steel are the *Heavy Hex* type (larger heads) but our new 3/8”, 1/4” and 5/16” will have to be *Finished Hex Head* (smaller heads). This is a long way of saying our A307 bolt library will be a mixture of two types….. *Heavy Hex Bolts* for 1/2” and up, *Finished Hex Head Bolts* for 3/8” and down.
The nuts (A563) and washers (F36) are not limited to 1/2” smallest, and include 3/8”, 1/4” and 5/16” sizes. Advance Steel already has the A563 nuts and F36 washers for 3/8”, 1/4” and 5/16”, so we won’t need to add those. These are the nuts and washers we will be building our sets with, as there is no such thing as “A307 nuts” or “A307 washers”.
The grade shown on all of the A307 and A325 bolts in Advance Steel is “10.9”, but that grade is meant for metric hardware.

1) Before starting, back up astorbase.mdb (not kidding, I had a mess when I first tried this!)
I just copied it in the same place with the date added on like “astorbase – copy 6-15-18.mdb”

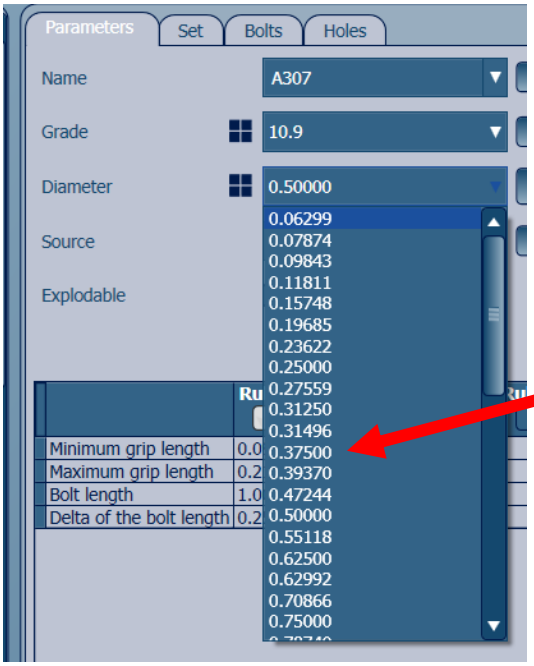
2) In MT, options, set current author to “my company”

Go to MT, bolts, A307 and pulldown diameter. You (might) get this.



Notice, two 1/16”…. two 1/8”…. two 3/16”.

Now go into MT, units selection and change from architectural with 1/16” precision to decimal (inch) with 0.00000 precision. Go back and note the difference, there wasn’t two 3/8” but rather one 0.37500” and one 0.39370. Of course we want the 0.3750 (3/8”) but many of the other sizes don’t correspond to fractions. It turns out they are inch equivalents of even millimeters. For example 7mm = 0.27559” (which is listed). The thing to note here is make sure you are picking the size you want and not a rounded off metric value posing as an inch fraction! And if you want a size that’s not there (like 7/16” = 0.4375”, you will need to add it)

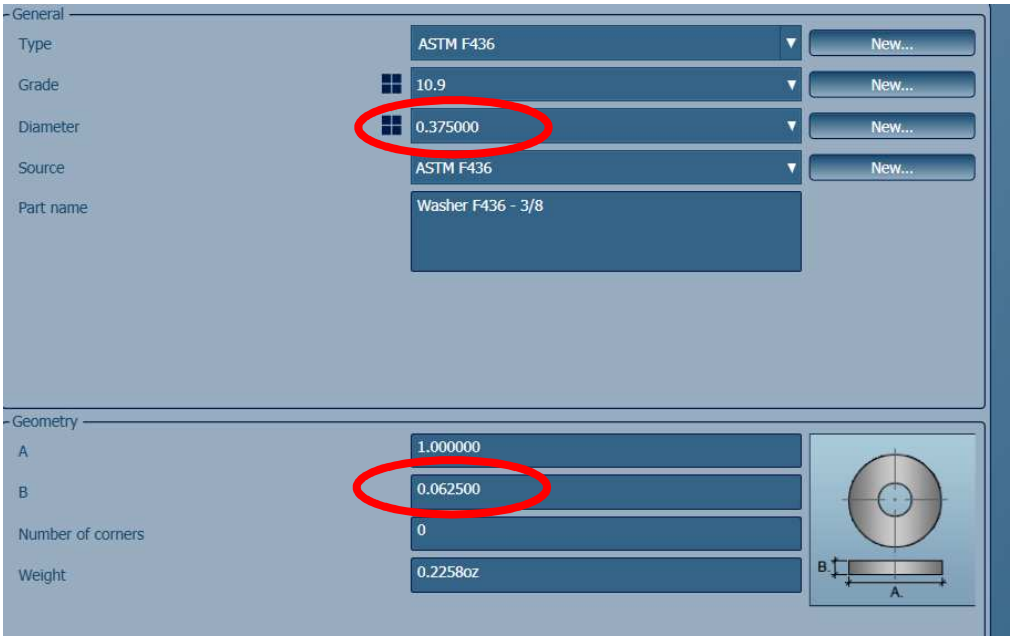


Notice, not two 3/8” but rather 0.37500” and 0.39370” (which is 10.00mm)

Before we do anything in MT, we need to organize our bolt lengths, bolt sets, bolt weights, bolt head geometry and grip rules.

Bolt lengths… what length of bolts are we adding? For 3/8”, I decided to add the sizes McMaster-Carr has listed for their A307 bolts. Start with 0.50” with 0.25” increments to 3.5”. Then by 0.5” to 8”, then by 1” to 12” long. This will all get organized in a spreadsheet below.

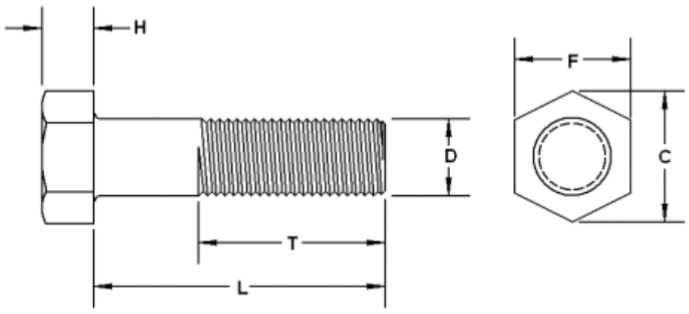
Bolt sets…. Let’s do the three most common boltsets, “N” (just a nut) “NaW” (Nut and washer) and “Na2W” (Nut and two washers). The nuts and washers will be A563 and F36 as discussed above. I went into MT and got the thickness of 3/8” A563 nut (B=0.337”) and 3/8” F36 washer (B=0.0625”) for my stackup/grip calculations. Again, it will all go in the spreadsheet.



Bolt weights….I got the bolt weights from a catalog page and will put these into a spreadsheet to automatically calculate the weight for each bolt. Note those formulas are in pounds, the spreadsheet will convert them to ounces. The nut and washers already have weights.

Finished Hex Head Bolts

Grade 2, 5, 8 and L9

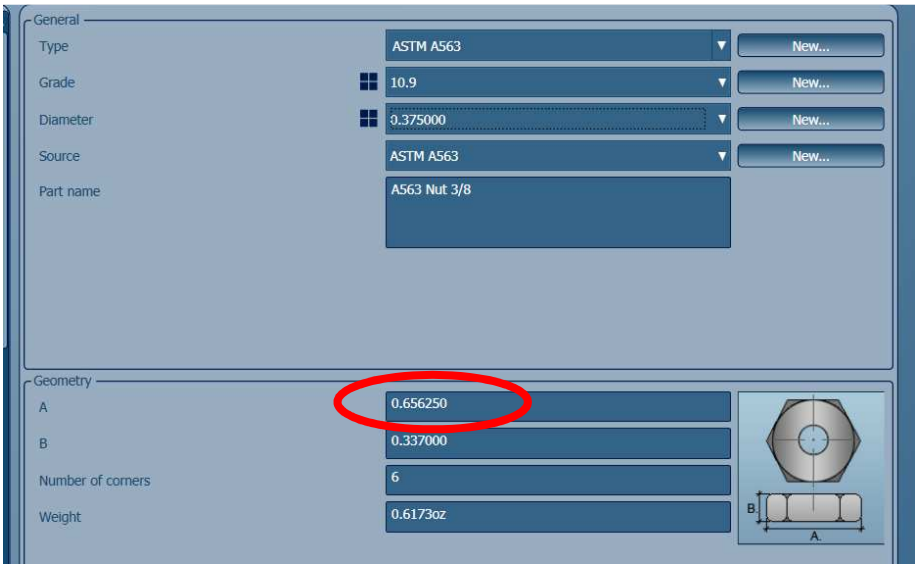


SAE Grade 2, ASTM A307	Plain = HC020-------	Zinc = HC020-------Z1
SAE J429 Grade 5, ASTM A449	Plain = HC050-------00D	Zinc = HC050-------Z1D
SAE J429 Grade 8, ASTM A490	Plain = HC080-------00D	Zinc = HC080-------Z1D
SAE J429 Grade L9, ASTM F606 (Note 1)		Zinc = HCL90-------Z1

Tap Bolts/Fully Threaded HCT020------- HCT050------- HCT080-------

Bolt Diameter	D	F			C		H	Weight
	Body Diameter	Width Across Flats			Width Across Corners		Height	Rough Estimate
	Max	Basic	Max	Min	Max	Min	Basic	Per Each
¼	0.260	7/16	0.438	0.425	0.505	0.484	11/64	.003 + .014 x inch
5/16	0.324	1/2	0.500	0.484	0.577	0.552	7/32	.007 + .021 x inch
3/8	0.388	9/16	0.562	0.544	0.650	0.620	1/4	.012+ .030 x inch
1/2	0.515	3/4	0.750	0.725	0.866	0.826	11/32	.034 + .055inch

Bolt head geometry….. We want our 3/8” bolt to have 9/16” across the flats which is exactly 0.6495 across the points (agrees with the chart above 0.650 – 0.620). The 3/8” A563 nut that is already in Advance Steel is A=0.656250” (see pic below) so let’s use that value so our new bolt will have exactly the same size head as the existing nut. The head height B=0.25” (from chart) and of course, 6 sides☺.



Grip rules…. Now for the real fun!! This took by far the longest to figure out, and this is how I did it. I made a spreadsheet (shown below) with all of the bolt lengths. I added a column that calculated the weight in oz. I made three groupings for the three boltsets (N, NaW & Na2W). In each of these groups there were 3 columns. The first column was the combined thickness of all the washers/nut for that boltset. (see above "bolt sets" to see where these values came from). The next column labeled "free" is how much space is left on that bolt, i.e. it is the length of the bolt minus the stackup of washer and nut. I decided to calculate my grips by specifying a minimum stickout (0.08" on spreadsheet) so if the stickout got less than 0.08" it goes to the next size. The max grip column is the free length minus the minimum stickout. You should be able to reproduce this in a spreadsheet.

So how does it work? Say you have a grip of 1" and NaW boltset. Looking at the appropriate "max grip" column, 1" is more than 0.7705 but less than 1.0205, so the length of the bolt is 1.50". Try another, 2.5" grip for N boltset, more than 2.333" but less than 2.583" so the length of the bolt is 3".

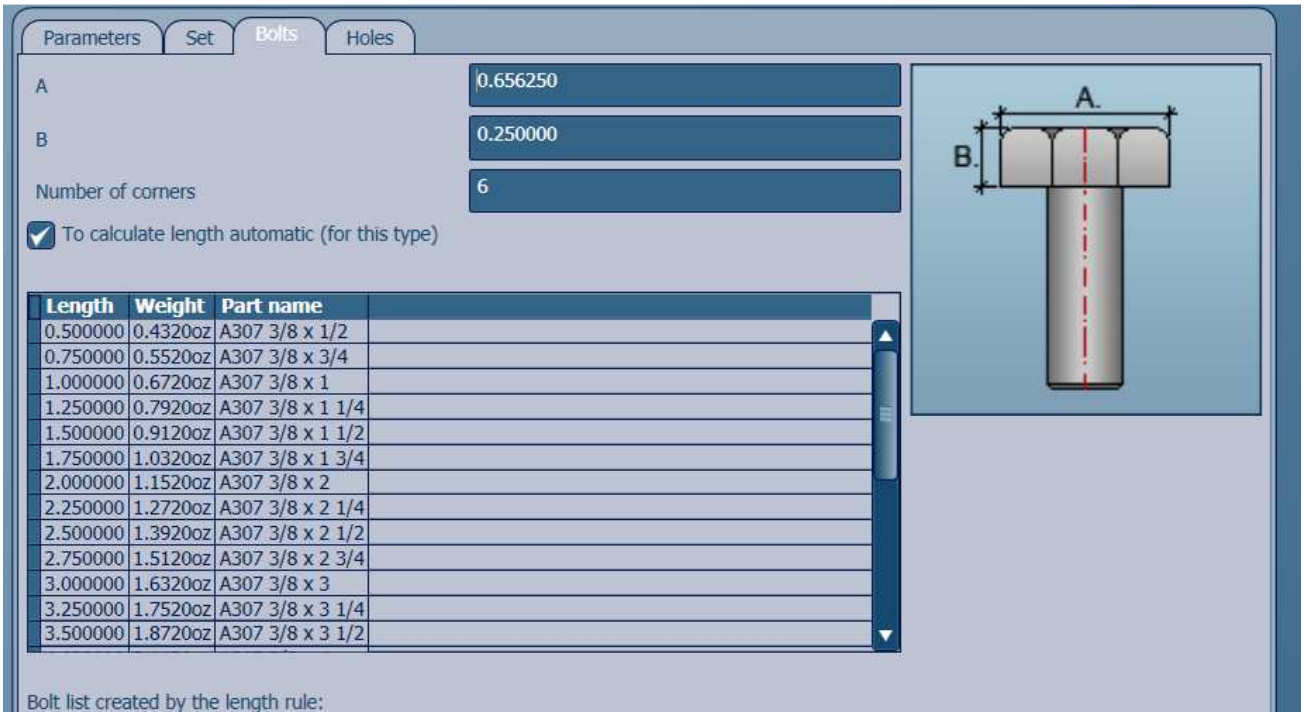
The yellow highlighted columns have to do with the rules that we will enter soon.

NUT B=	0.337									
WASHER B=	0.0625									
MIN STICKOUT =	0.08				nut			nut		
		nut			washer			2 washer		
3/8 bolt length	wt (oz)	N	free	max grip	NaW	free	max grip	Na2W	free	max grip
0.5000	0.432	0.337	0.1630	0.0830	0.3995	0.1005	0.0205	0.462	0.0380	-0.0420
0.7500	0.552	0.337	0.4130	0.3330	0.3995	0.3505	0.2705	0.462	0.2880	0.2080
1.0000	0.672	0.337	0.6630	0.5830	0.3995	0.6005	0.5205	0.462	0.5380	0.4580
1.2500	0.792	0.337	0.9130	0.8330	0.3995	0.8505	0.7705	0.462	0.7880	0.7080
1.5000	0.912	0.337	1.1630	1.0830	0.3995	1.1005	1.0205	0.462	1.0380	0.9580
1.7500	1.032	0.337	1.4130	1.3330	0.3995	1.3505	1.2705	0.462	1.2880	1.2080
2.0000	1.152	0.337	1.6630	1.5830	0.3995	1.6005	1.5205	0.462	1.5380	1.4580
2.2500	1.272	0.337	1.9130	1.8330	0.3995	1.8505	1.7705	0.462	1.7880	1.7080
2.5000	1.392	0.337	2.1630	2.0830	0.3995	2.1005	2.0205	0.462	2.0380	1.9580
2.7500	1.512	0.337	2.4130	2.3330	0.3995	2.3505	2.2705	0.462	2.2880	2.2080
3.0000	1.632	0.337	2.6630	2.5830	0.3995	2.6005	2.5205	0.462	2.5380	2.4580
3.2500	1.752	0.337	2.9130	2.8330	0.3995	2.8505	2.7705	0.462	2.7880	2.7080
3.5000	1.872	0.337	3.1630	3.0830	0.3995	3.1005	3.0205	0.462	3.0380	2.9580
4.0000	2.112	0.337	3.6630	3.5830	0.3995	3.6005	3.5205	0.462	3.5380	3.4580
4.5000	2.352	0.337	4.1630	4.0830	0.3995	4.1005	4.0205	0.462	4.0380	3.9580
5.0000	2.592	0.337	4.6630	4.5830	0.3995	4.6005	4.5205	0.462	4.5380	4.4580
5.5000	2.832	0.337	5.1630	5.0830	0.3995	5.1005	5.0205	0.462	5.0380	4.9580
6.0000	3.072	0.337	5.6630	5.5830	0.3995	5.6005	5.5205	0.462	5.5380	5.4580
6.5000	3.312	0.337	6.1630	6.0830	0.3995	6.1005	6.0205	0.462	6.0380	5.9580
7.0000	3.552	0.337	6.6630	6.5830	0.3995	6.6005	6.5205	0.462	6.5380	6.4580
7.5000	3.792	0.337	7.1630	7.0830	0.3995	7.1005	7.0205	0.462	7.0380	6.9580
8.0000	4.032	0.337	7.6630	7.5830	0.3995	7.6005	7.5205	0.462	7.5380	7.4580
9.0000	4.512	0.337	8.6630	8.5830	0.3995	8.6005	8.5205	0.462	8.5380	8.4580
10.0000	4.992	0.337	9.6630	9.5830	0.3995	9.6005	9.5205	0.462	9.5380	9.4580
11.0000	5.472	0.337	10.6630	10.5830	0.3995	10.6005	10.5205	0.462	10.5380	10.4580
12.0000	5.952	0.337	11.6630	11.5830	0.3995	11.6005	11.5205	0.462	11.5380	11.4580

Now that we have all this info in hand, time to enter it into MT.

Go to Bolts, A307, “parameters tab” and select 0.37500” from diameter pulldown. Put A307 in the Source pulldown box. Hit apply.

Go to the “bolts tab” and enter the head geometric info and all of the bolt sizes with their names and weights. I don’t know a fast way to cut and paste all of those sizes at once, I had to basically enter each cell individually. When finished, hit apply.

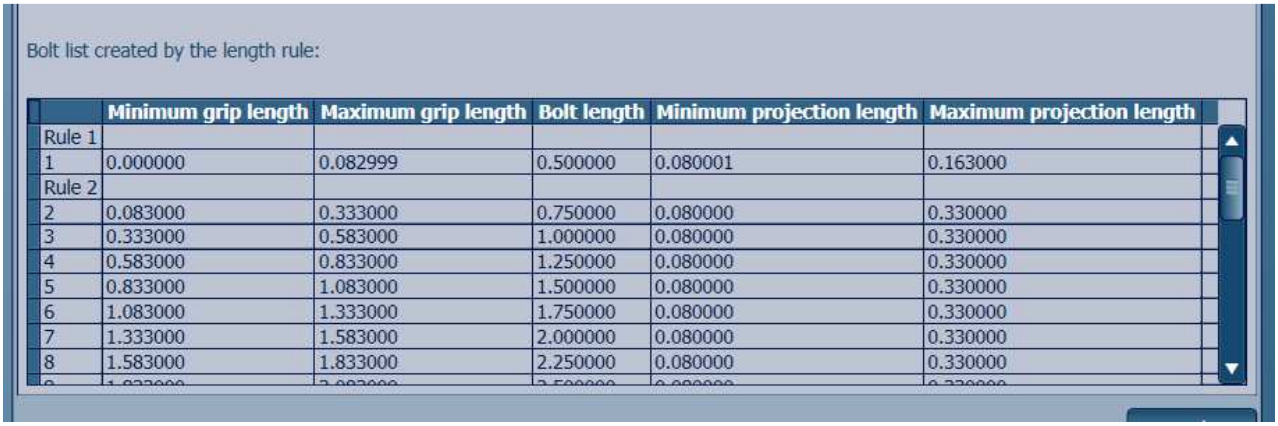


Click on the “set tab”. Let’s start with the “N” set. Select N from the pulldown. Now in the lower box, click the “+” and add a 0.375” ASTM A563 grade 10.9 nut. Hit apply.

Go back to the “parameters tab”. Enter the rules for the “N” set. Type them in exactly as you see below. The rules are complicated to follow, it is easier to look at them then to explain them. You can see the yellow highlights in the spreadsheet to see where those numbers came from. Note, I made the maximum grip lengths 0.000001” less (like 0.082999 instead of 0.083000). It seems to behave better if there is no overlapping. Hit apply.

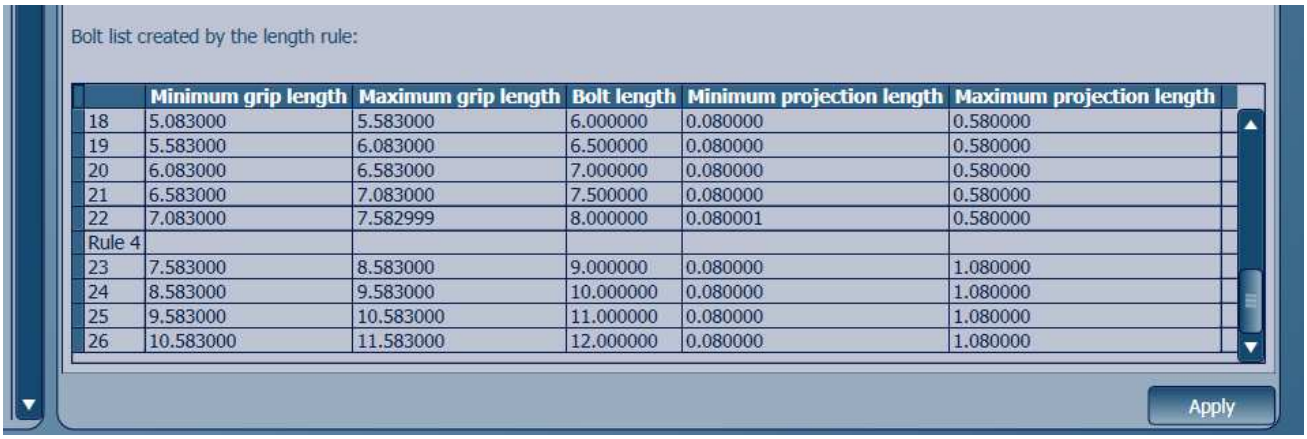
	Rule 1	Rule 2	Rule 3	Rule 4	Rule 5
Minimum grip length	0.000000	0.083000	3.083000	7.583000	
Maximum grip length	0.082999	3.082999	7.582999	11.583000	
Bolt length	0.500000	0.750000	4.000000	9.000000	
Delta of the bolt length	0.250000	0.250000	0.500000	1.000000	

Now go back to the “bolts tab” and you will see the “bolt list created by length rule” has been populated. Remember, this is just for the “N” set. But you can see, for a given grip, this table will determine the bolt length, and it should match how the spreadsheet determines lengths. Also, notice the “minimum projection length” column all shows 0.080000” which is what we had originally wanted. Go through these rules, make sure they agree with the spreadsheet. If any of the “minimum projection length” columns are not 0.080000”, this indicates a problem with the rules (especially if it’s a negative number).



Bolt list created by the length rule:

	Minimum grip length	Maximum grip length	Bolt length	Minimum projection length	Maximum projection length
Rule 1					
1	0.000000	0.082999	0.500000	0.080001	0.163000
Rule 2					
2	0.083000	0.333000	0.750000	0.080000	0.330000
3	0.333000	0.583000	1.000000	0.080000	0.330000
4	0.583000	0.833000	1.250000	0.080000	0.330000
5	0.833000	1.083000	1.500000	0.080000	0.330000
6	1.083000	1.333000	1.750000	0.080000	0.330000
7	1.333000	1.583000	2.000000	0.080000	0.330000
8	1.583000	1.833000	2.250000	0.080000	0.330000

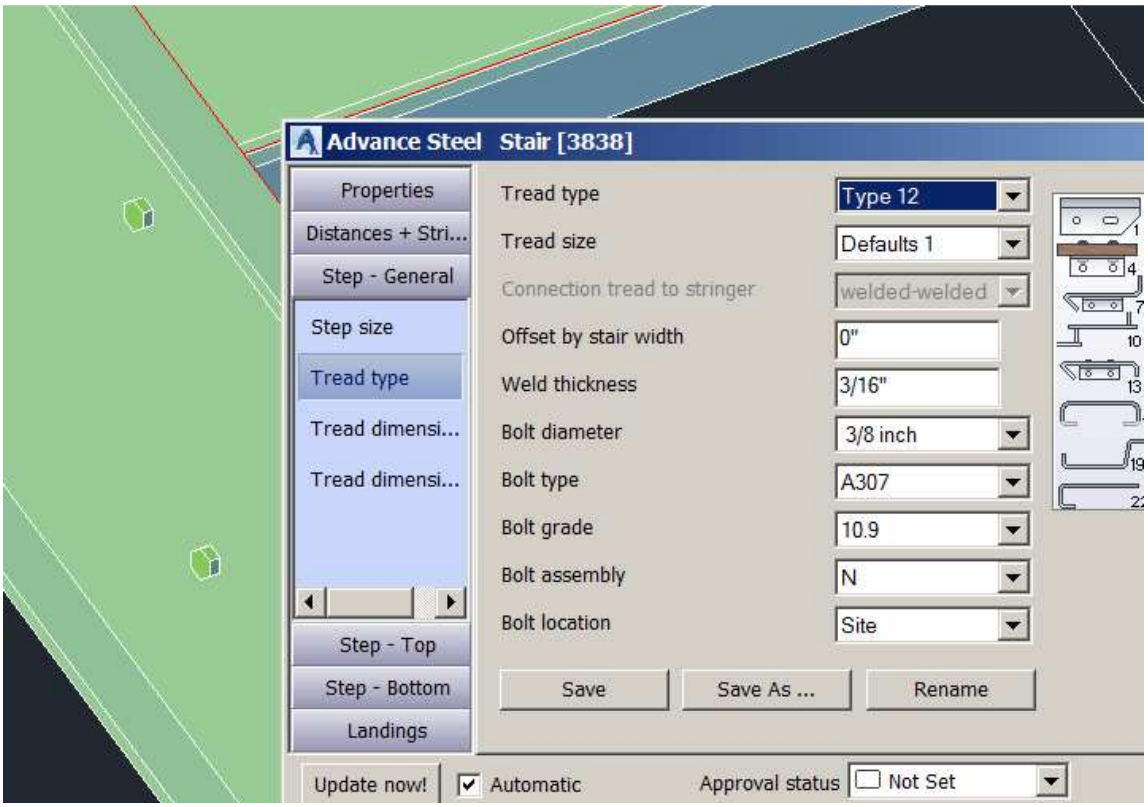


Bolt list created by the length rule:

	Minimum grip length	Maximum grip length	Bolt length	Minimum projection length	Maximum projection length
18	5.083000	5.583000	6.000000	0.080000	0.580000
19	5.583000	6.083000	6.500000	0.080000	0.580000
20	6.083000	6.583000	7.000000	0.080000	0.580000
21	6.583000	7.083000	7.500000	0.080000	0.580000
22	7.083000	7.582999	8.000000	0.080001	0.580000
Rule 4					
23	7.583000	8.583000	9.000000	0.080000	1.080000
24	8.583000	9.583000	10.000000	0.080000	1.080000
25	9.583000	10.583000	11.000000	0.080000	1.080000
26	10.583000	11.583000	12.000000	0.080000	1.080000

Apply

And……You're Done!! Get out of MT, restart AS, and play around with your new 3/8" A307 bolts. If you can't find them, make sure the bolt assembly is set to "N" and not "NaW" because we have not put in the "NaW" 3/8" set yet. To put in the NaW and Na2W, you just need to add them in the "set tab" and tweak the values in the rules with the spreadsheet ones.



Here are the other rules. This is for "NaW" (nut and washer)

	Rule 1	Rule 2	Rule 3	Rule 4
Minimum grip length	0.000000	0.020500	3.020500	7.520500
Maximum grip length	0.020499	3.020499	7.520499	11.520500
Bolt length	0.500000	0.750000	4.000000	9.000000
Delta of the bolt length	0.250000	0.250000	0.500000	1.000000

And here is for "Na2W" (nut and 2 washers) Note the differences since the 0.50" long bolt has a negative grip in the spreadsheet.

	Rule 1	Rule 2	Rule 3	Rule 4
Minimum grip length	0.000000	0.208000	2.958000	7.458000
Maximum grip length	0.207999	2.957999	7.457999	11.458000
Bolt length	0.750000	1.000000	4.000000	9.000000
Delta of the bolt length	0.250000	0.250000	0.500000	1.000000