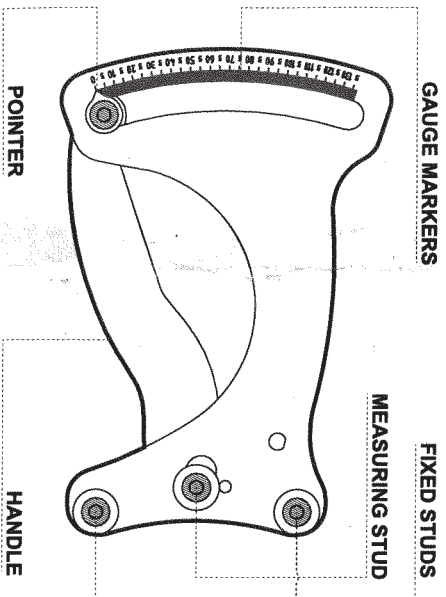


X-TOOLS

SPOKE TENSION METER

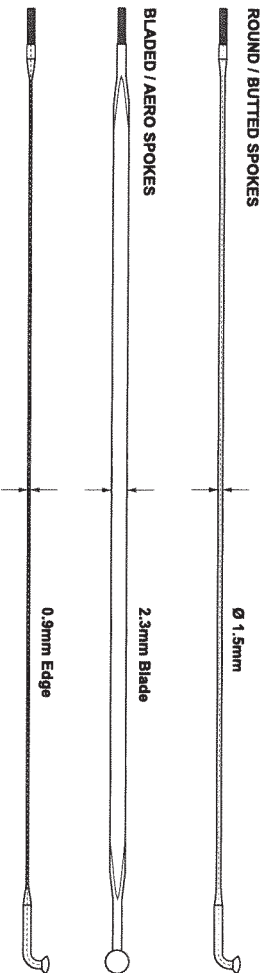


Strong and consistent spoke tension is essential for a stiff and durable wheel. The X-Tools Spoke Tension Meter provides a calibrated measurement of the spoke tension to help you get the best out of your wheel build.

Please consult your spoke and rim manufacturer's recommended spoke tensions. As a general rule, the tension should be high enough to prevent slackness or flex when the wheel is in use.

MEASURING THE SPOKE DIMENSIONS

Use a gauge tool or a Vernier caliper to measure the gauge of the spoke. For butted spokes, measure the diameter of the spoke at the narrowest point. For bladed spokes, measure both the width and the edge of the blade.



Make a note of the spoke dimensions, check the unit conversion table to ensure your spoke dimensions are listed.

If your spokes do not conform to the dimensions listed in the unit conversion table, it may not be possible to gain an accurate absolute tension value in kilograms/force. The X-Tools Spoke Tension Meter can still be used to measure the relative tensions of the spokes to help ensure the wheel is tensioned evenly.

MEASURING SPOKE TENSION

Mount the wheel in a truing jig. Mark the first spoke with a small strip of adhesive tape at the nipple for easy reference. Gently squeeze the handles of the tension meter, slot the spoke between the fixed studs and measuring stud [FIG 1]. For radial laced wheels, position the measuring stud at the mid point of the rim and for wheels with crossed lacing patterns, position the measuring stud at the mid point between the rim and the cross. Ensure you measure the tension at the same point on each spoke.

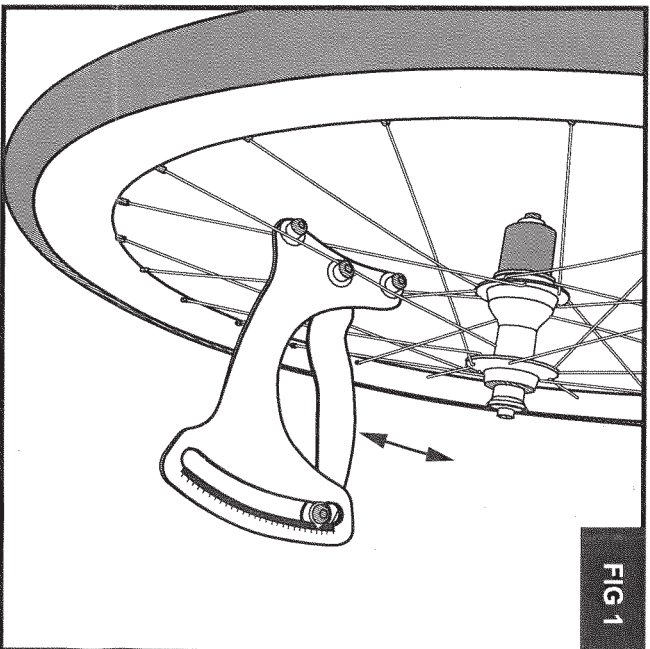


FIG 1

Slowly release the handle and allow the measuring stud to rest fully on the spoke. Examine the measurement gauge and record the value indicated by the pointer. Repeat for each spoke on the same side of the wheel.

Please note: The spoke tensions on opposite sides of disc brake compatible wheels and geared rear wheels will not be the same. This is due to the differing spoke lengths and angles required to dish the rim centrally.

CONVERTING THE METER READINGS TO KILOGRAM-FORCE (kgf)

Locate the corresponding column for your spoke type and dimensions on the unit conversion table. Match your recorded readings to the kgf (Kilogram-force) values given for your spoke type/dimension. Eg. A round spoke with a 1.8mm diameter that gives a reading of 51 converts to 119 kgf tension. A Bladed Spoke with a 2.3mm width and 0.9mm edge that gives a reading of 32 converts to 122 kgf tension.

CALCULATING AVERAGE TENSION

For wheels with symmetrical hubs such as rim brake compatible front wheels, all of the spokes will be comparable.

For hubs with asymmetrically spaced flanges such as disc brake compatible hubs and geared rear hubs, only the spokes on the same side of the wheel are comparable with one-another.

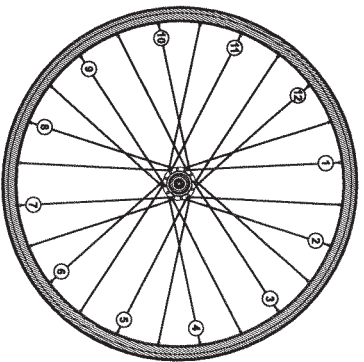
- Record the tension readings for all comparable spokes.
- Add the values together.
- Divide the total by the number of comparable spokes.
- Match the average recorded reading to the kgf value on the conversion table.

CALCULATING AVERAGE TENSION (continued)

EXAMPLE:

The drive side of a 24 spoke rear wheel (12 spokes). Spoke Type: Bladed Spoke with a 2.3mm width and 0.9mm edge.

| SPOKE NUMBER | MEASURED READING | kgf VALUE |
|--|------------------|-----------|
| 1 | 30 | 101 |
| 2 | 30 | 101 |
| 3 | 30 | 101 |
| 4 | 31 | 111 |
| 5 | 31 | 111 |
| 6 | 31 | 111 |
| 7 | 30 | 101 |
| 8 | 30 | 101 |
| 9 | 29 | 92 |
| 10 | 28 | 84 |
| 11 | 30 | 101 |
| 12 | 28 | 84 |
| Average Spoke Tension (Total kgf / 12) | | 99.2 kgf |



CALCULATING RELATIVE TENSION

Relative tension is the difference between the tension of an individual spoke and the average tension of the comparable spokes in the wheel. Generally, the acceptable variation in spoke tension is plus or minus 20%.

- Divide the individual spoke tension by the average spoke tension value in Kg/f.
- Multiply the result by 100

| SPOKE NUMBER | SPOKE kgf VALUE | AVERAGE kgf VALUE |
|---|-----------------|-------------------|
| 10 | 84 | 99.92 |
| Relative Tension $(84 / 99.2) \times 100$ | | 84.06% |

The relative tension of spoke 10 is 84% : within the 20% acceptable margin.

NB: The flange spacing of Modern 11 speed rear hubs is often very asymmetrical. The drive side of the wheel may feature shorter spokes at a steeper angle. The average tension of the drive side might be considerably higher than the non-drive side.

WARNING

- Cycling with improperly tensioned spokes can lead to wheelset failure and possible injury. If you have any doubts about your wheelset build, please consult a professional cycle mechanic.
- Do not exceed the maximum spoke tensions recommended by the spoke and rim manufacturers.
- Do not adjust the spring tension of the spoke tension meter, this has been carefully calibrated during manufacture.
- Store in a clean and dry environment.

ROUND / BUTTED SPOKES

| MEASURED READING | SPOKE DIAMETER | | | | | |
|------------------|----------------|------|------|------|------|------|
| | Ø2.3 | Ø2.0 | Ø1.8 | Ø1.7 | Ø1.6 | Ø1.5 |
| 21 | | | | | | |
| 22 | | | | | | |
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| 30 | | | | | | |
| 31 | | | | | | |
| 32 | | | | | | 44 |
| 33 | | | | | | 47 |
| 34 | | | | | 43 | 46 |
| 35 | | | | | 46 | 50 |
| 36 | | | | | 50 | 53 |
| 37 | | | | | 43 | 54 |
| 38 | | | | | 47 | 58 |
| 39 | | | | | 51 | 62 |
| 40 | | | | | 55 | 68 |
| 41 | | | | | 60 | 75 |
| 42 | | | | | 45 | 81 |
| 43 | | | | | 49 | 90 |
| 44 | | | | | 55 | 76 |
| 45 | | | | | 62 | 85 |
| 46 | | | | | 70 | 94 |
| 47 | | | | | 79 | 103 |
| 48 | | | | | 89 | 113 |
| 49 | | | | | 45 | 99 |
| 50 | | | | | 52 | 110 |
| 51 | | | | | 59 | 119 |
| 52 | | | | | 68 | 130 |
| 53 | | | | | 77 | 145 |
| 54 | | | | | 87 | 165 |
| 55 | | | | | 100 | |
| 56 | | | | | 110 | |
| 57 | | | | | 124 | |
| 58 | | | | | 146 | |
| 59 | | | | | 170 | |
| 60 | | | | | 39 | |
| 61 | | | | | 46 | |
| 62 | | | | | 54 | |
| 63 | | | | | 62 | |
| 64 | | | | | 68 | |
| 65 | | | | | 78 | |
| 66 | | | | | 90 | |
| 67 | | | | | 106 | |
| 68 | | | | | 126 | |
| 69 | | | | | 145 | |
| 70 | | | | | 167 | |

UNITS: kgf (Kilogram-force)

BLADED / AERO SPOKES

| MEASURED READING | SPOKE DIMENSIONS | | | | | | | | | |
|------------------|------------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-----------|
| | 2.0 x 1.25 | 2.0 x 0.9 | 2.8 x 1.3 | 2.3 x 0.9 | 3.3 x 1.0 | 2.3 x 1.2 | 3.2 x 1.0 | 2.0 x 0.95 | 1.7 x 0.9 | 4.8 x 1.0 |
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UNITS: kgf (Kilogram-force)