



## Trust in Sapim spokes

Dear Friend,

As you know, bicycle and wheel technology has developed considerably over the last few years: the increasing use of materials such as carbon-fibre, different aluminium alloys, titanium and stainless steel, means you continually need to update your wheelbuilding skills. Lighter wheels and light-weight bikes create new demands. Twenty-one speed gearing and disc brakes has affected wheel geometry and added to material fatigue.

Sapim's Research and Development Department is able to offer you advice on wheelbuilding which conforms with Product Liability and Customer Safety Regulations. This document is prepared with the assistance of professional mechanics working in MTB and Road racing.

Yours in sport,

### Sapim's advice on building and maintaining good wheels

#### FACTS

#### COMMENTS

##### Correct spoke length

→ After the wheel is centred, the spoke will be visible at the top of the nipple.

##### Choice of the spoke type

- Suited to both wheel construction and bicycle type.
- It is not correct to think that a thicker spoke makes a stronger wheel.
- A stronger wheel is obtained by using a thinner (more flexible) spoke,
  - for hubs with large holes, use Sapim Leader Ø 2.30 mm spokes
  - when the spokes in the wheel show a mis-alignment to the nipple, use Sapim Strong Ø 2.30 mm spokes, butted to 2.00 mm; very often they improve the spoke-nipple alignment.
- For race wheels, Sapim CX-Ray and Sapim RACE are preferable; they are more resistant to vibrations.
- For MTB and CYCLO CROSS we advise the use of Sapim CX-Ray, Sapim RACE or Sapim LASER (do not use Sapim Laser in wheels with disc brakes).

### Choice of cross pattern

The fatigue test diagram is in our catalogue see “[www.sapim.be](http://www.sapim.be)”

- Cross lacing gives a more stable assembly.
- Most standard method is 3 cross  
(pay attention to a gap in the spoke-nipple alignment!)
- Be careful with radial assembly (see the hub supplier’s recommendations).
- For extra large hub flanges like Nexus, Elan etc., which have a greater risk of spoke/nipple mis-alignment, you should cross 2.

### Pull/push spokes

- Once correctly mounted,
  - the pull spoke heads are visible inside flange
  - the push spoke heads are visible outside flange

**Attention: disc brakes are an exception, as the highest stress occurs while braking (Downhill - MTB).**

### Is there a gap between the spoke neck and hub flange?

- A gap might occur between the spoke bend/hub flange and spoke/nipple connection.
- Check:
  - Is the hub flange suited to the spoke bend?
  - Cross pattern
  - Flange holes are offset
  - Wheel geometry

### Choice of nipple length: 12-14-16 mm (Special nipples are 19-21-25 mm long)

- Use Sapim Polyax nipples for an optimum spoke-nipple alignment.
- Do not choose extra long nipples as this will cause the spoke-nipple alignment to deteriorate.
- Do not use nipples which are too short (insufficient grip on the square part will cause damage to the nipple, particularly if it is alloy).

### Nipples loosening?

- High-profile or radially mounted wheels suffer bad vibrations, particularly on poor road surfaces.
- SILS-nipples (Sapim Integrated Locking System) have a special thread system which prevents loosening. A SILS nipple, which is self-locking, can be recentred as often as you want.
- For nipples with oil-free threads, SAPIM FREEZE glue is very useful; this glue has been especially formulated for repetitive wheel centring.
- Always choose a solid, high-quality rim because it offers lateral and vertical stability / stiffness.

### Rim is sound

- Hold the hub flange horizontally. Put the spoke, with the head inside, a little higher. While centring, you should push on the hub lightly; the spokes will easily adjust themselves. (Attention: do not push so hard that the spokes bend!).
- Using oversized hub holes is an easy solution. However, this will cause a lot of play and is not recommended.

- Hub hole suitability**
- Consider the use of spoke washers.
  - Too much tension on the spoke head will also cause problems.
  - Ideal hub hole  $\varnothing$  equals spoke thread  $\varnothing + 0.1$  mm (eg. spoke thread on 14G/2 mm measures thread  $2.25 \text{ mm} + 0.1 = 2.35$  mm: max. hole  $\varnothing$  2.50 mm).
- Pull/push spokes**
- The hub should have flanges which allow a proper spoke /nipple alignment. The flange angle should be  $95^\circ$  ideally.
  - Make sure you have an equal flange position; more equal spoke tension per wheel side will be obtained.
- Hub flange positioning**
- Please note:
    - flanges which are too thin and / or hub holes which are too large in which case the spoke angle of  $95^\circ$  could increase to  $120^\circ$
- Correctly mounted SAPIM spokes never elongate. However, an incorrect hub can cause the bending angle to enlarge (elongation of the bend up to +1.5 mm per spoke) and buckle wheels.**
- Oversized flanges cause extra pressure on the spoke heads. In consequence, the heads pop off.
  - Consider spoke washers

**A good wheel** is a wheel in which each spoke takes a proportional part of the total stress.

## Facts

---

A survey of frequent incidents recorded by our laboratory research team and race mechanics.

### → When do spokes or other wheel components break?

**Spokes in a correctly built wheel only break as a result of normal metal fatigue after years of intensive use.**

- At the end of its life, the material has lost its original cohesion and elasticity.
- If material is forced while lacing the hub, the spokes can be pulled over causing material weakness. The original bend angle of  $95^\circ$  should remain intact.
- Most wheel or spoke breakages occur as a result of insufficient and/or irregular spoke tension.
- A spoke breaks when metal fatigue passes a critical point. Good assembly can increase the resistance to breakage. The art of wheel building is to create an equal increase in the tension of all the spokes individually and at the same time to make sure that the rim stays round and true. When a wheel is built, bring the spokes to a final equal tension. A perfect wheel does not run out of true when it is used; instead it actually helps to prevent metal fatigue in spokes, rim and hub.
- Weight is a factor: 90 kg (200 lbs) on loosely tensioned wheels will always cause them to ovalise. Constant flex within the wheel will cause premature fatigue, especially in spokes. In other words: the wheel should retain its original shape as much as possible.

## → Where and when does a spoke break?

### Normally just before the bend (this is fairly standard after many years use)

- The rim has been damaged - even the smallest dent can be the cause;
- The use of non-compatible components;
- Irregular tension on the spokes;
- A gap exists in the spoke-nipple alignment;
- Is it possible to replace 1 or 2 spokes or do you have to replace all the spokes and re-spoke the wheel? If you do not re-spoke the wheel, the replaced spokes will have to be very tightly tensioned if the wheel is to be round and true. Do not forget when the first spoke breaks, all the other spokes suddenly have a different tension pattern! Also the rim structure goes out of line. If you only replace 1 or 2 spokes, you can expect these or the spokes next to them to break again. It is best to re-spoke the entire wheel and to replace the hub just in case the hub holes are damaged. It is possible to re-use the hub by mounting the spokes in the opposite direction (i.e. not in the direction of the ovalisation of the hub holes).

### The spoke head breaks off (this is unusual)

- Bad positioning of the head in the hub (e.g. a slant position puts all the pressure on one side of the bottom of the spoke head. As a result the head snaps off, the so-called "bottle cap effect").
- The hub flange is too thick and is not suited to the length of the spoke bend (i.e. all the pressure is on the head, which will be excessively stressed and rip off).
- If the wrong cross pattern is chosen, e.g. cross 4 on large flange hubs, the spoke bend can rub against the adjacent spoke head. This should be avoided.

### The spoke thread breaks in the nipple

- This often occurs as a result of nipple/rim and spoke mis-alignment.
- If spokes are used which are too long, new threads in the nipple will be made. Under heavy pressure the spoke threads will be stressed too greatly.
- Spokes which are too short may also break at the spoke thread.

### When the thinner middle section breaks (on single or double butted spokes)

- Any object striking a moving wheel causes damage (sometimes only visible with a magnifying glass or microscope).
- Top quality manufacture will safeguard against damage. Lower standard processes will produce an inferior quality. SAPIM draws wire in such way that no change in molecular material structure occurs. The spoke does not twist much when it is built into a wheel.
- Aerodynamic, elliptical spokes, such as the SAPIM CX-Ray spoke, are best fitted with a special CX-Ray key. This will prevent the spokes from twisting during lacing and centring.

**We thank the teams currently using SAPIM spokes:** Rabobank Team, Mapei-Quick Step-Colnago, Team Telekom, US Postal Cycling Team, CSC- Tiscali, Palmans-Collstrop, Landbouwkrediet-Colnago, Gerolsteiner, Vouilloz Racing team, Karl Platt, Benny Vansteelant, and many, many others.

**We also offer special thanks to the team mechanics and all the MTB-mechanics for their technical assistance,** and especially to Gilbert Cattoir, Julien De Vriese (US Postal Cycling), Louis Van Roosbroeck (Rabobank), Christophe Desimpelaere (CSC Tiscali) and many others who contributed to this 'checklist for a good wheel'.

**The SAPIM-team**

**SAPIM® SPOKES AND NIPPLES**

Terbekehofdreef 65  
2610 Wilrijk (Antwerp)  
**Belgium**

Tel.: +32 (0)3 740.08.20  
Fax: +32 (0)3 828.81.39  
info@sapim.be

**WWW.SAPIM.BE**