Lew Racing Pro VC-1 Bead Seat Clincher (BSC)™

A traditional clincher rim attaches the tire by lodging the tire bead under a hook in the most outer diameter of the rim. This style of clincher rim is typically referred to as a hook-bead or crochet style rim. As the tire pressure increases, the force on the outer diameter hook portion of the rim increases. At 145 psi (10 bar), the hook must retain approximately 7975 pounds of total force from the air pressure in the tire. Figures 1 and 2 show a properly attached tire comparing a hook-bead clincher and a Lew VC-1 bead-seat clincher (BSC)™.

Figure 1:
Hook-bead clincher

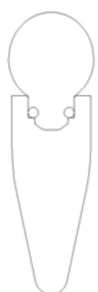

Figure 2:
VC-1 Bead-seat clincher

The VC-1 BSC™ design relies on the inner diameter of the tire chamber to register the bead of the tire (Refer to Figure 2, Figure 3, & Figure 4). The means of attachment of the tire to the rim is accomplished by the bead registering or seating on a perch located on the inner diameter of the rim chamber (Figure 4). This is a commonly accepted and understood wheel/ tire interlock for motorized vehicle wheels and tires, and it directs the 7975 pounds of force inward, toward a more secure position.

Figure 3: Photo of VC-1 Bead-seat clincher

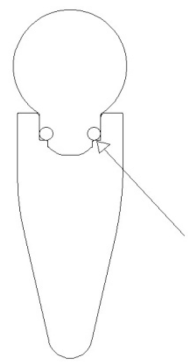

Figure 4:
Tire bead register on inner diameter
of the rim chamber

It is partially true that high pressure tires require a hook-style rim for retention. Metal wire bead tires tend to stretch, and particularly high pressures can grow the bead diameter a significant amount to dislodge the tire from the rim without the hook for retention. With the wide availability of folding, Kevlar™ bead tires, there is no concern for the diameter of the bead to increase with pressure. Kevlar™ does not elongate, and Kevlar™ beaded tires do not stretch. A Kevlar™ bead is the first step required to eliminate a hook bead design.

A hook shape in the outer edge of the rim creates a stiffer, stronger rim than a straight sidewall of the same wall thickness without the hook. The problem begins when carbon composite materials are applied to a traditional alloy design. The factor of safety of a carbon fiber hook in a carbon fiber hook-bead rim design is dangerously small as compared to the hook of an alloy hook-bead design.

Compression strength for aluminum alloy is approximately 42,000 psi as compared to just 28,000 psi for carbon fiber. If off-axis fibers and epoxy resin are taken into account the resistance to failure from compression in the hook bead region of a carbon fiber clincher drops to an amazingly low 4,608 psi, approximately one-tenth the strength of aluminum. The clincher tire is generating 7975 total pounds of outward force, so it's no wonder hook-bead carbon clinchers' durability suffers at higher tire pressures.

Fortunately, there are several remedies:
1) Change the nature of low compression strength carbon fiber by reinforcing it with Boron fiber, which is roughly equal to aluminum in compression.
2) Modify the tire-rim interface to a more composite friendly design-- one that utilizes the outstanding tensile properties of carbon composite, while minimizing the effect of the poor compression strength.
3) Add material to the critical high-stress regions where the tire loads the rim with the most stress.

The VC-1 rim contains three times the amount of material in the sidewall (figure 6), and tire interface region than a traditional hook rim clincher, thereby improving the strength over a typical carbon hook-bead clincher (figure 5) design by over 300% without factoring in the added compression strength in these areas from the boron fiber structure. As a result of the BSC design, the composite material in the sidewall is not subject to compression as a significant stress, but rather tension, where the composite material performs the best.

Figure 5: Typical hook region of a traditional style clincher rim measures approximately 0.05 inches

Figure 6: VC-1 BSC measures over three times the thickness of a traditional style clincher rim 0.17 inches

A high pressure tire creates significant force, pushing the sides of the tire chamber outward. As a result of high temperature from brake pad friction, combined with high tire pressure, a composite hook bead clincher rim can deform and buckle. Refer to Figures 7–10.

Figure 7: Detached tire as a result of bulging rim that was deformed as a result of heat and pressure

Figure 8: Deformed rim as a result of heat and pressure


Figure 9: Deformed, weakened hook portion of rim


Figure 10: Deformed rim sidewalls have spread approximately 0.15 inches (3.8 mm)

The aforementioned design features there are additional benefits to the VC-1 that prevent rim deformation under high-heat braking conditions. First, VC-1 rims use a reinforcement quality (boron and high-modulus carbon) that far exceeds any other rim manufacturer’s standards modulus reinforcement. Second, high-temperature resin resists temperatures exceeding 400 deg F. Third, and most significantly, the high-pressure tire focuses the bead of the tire toward the bottom of the rim chamber opposite the point of highest load as opposed to upward and outward toward the hook of a traditional rim.

Why hasn't this been an acceptable means of tire and rim interface for bicycle rims in the past? In the automobile, and motorcycle industry it has, but the reason the cycling industry has not followed is complex. The answer is primarily because the approach to rim design has been driven by rolled alloy rims.

All alloy rims are not created equally. Alloy rim diameters vary significantly from rim-to-rim. Alloy rims are also known as "rolled" rims, meaning that they begin as a straight extrusion, they are cut to length, and then they are rolled and pinned, bonded or welded. Rolled rims begin as a long extrusion, often times in excess of 10 meters, and they are rolled and then cut off to length. As the rims come off of a rim rolling line, they resemble a coiled spring that is later cut every 360 degrees to create a hoop. To exaggerate the tolerance control problem the alloy rims are not flat, but rather they are twisted as a result of the coiled spring roll. The diameter of the rim varies based upon the accuracy of the cut length.

The length of an extrusion cut is the rim diameter times the constant PI. The tolerance of a cut length can vary significantly. With a welded steel rim (common in spoked motorcycle wheel) once the rim is welded, the rim goes to an "expander," and the diameter is precisely set, which is why rolled steel rims are often more accurate dimensionally than a rolled alloy rim. However, this is not possible to do to an alloy rim; the rim will crack or the bonded & pinned seam will separate. Therefore, the rolled diameter is the diameter the manufacturer must accept.

Because of the wide variation in rim diameter, the tire bead seat diameter (for example, 622 mm for a 700c clincher) is not precise enough to register a tire bead, and the rim must rely on a hook on the outer diameter to retain the tire. In theory, if the inside diameter of the tire chamber of the rolled alloy rim were machined after rolling, the bead seat diameter could be precisely registered.
Lew Racing has developed a molding technique to form a precise bead seat diameter of a consistent and repeatable dimension with variation of +/- 0.002" of an inch. The consistent accuracy of the bead seat diameter from one rim to the next is the reason the bead of the tire securely interlocks with the rim.

Does the Lew Racing Pro VC-1 design improve safety over the traditional hook design? Paul Lew's company, Lew Composites, developed the carbon tubular and clincher technology that was sold to Reynolds/ MCQ in 2002. His clincher technology, first developed in 1999 (now used by Reynolds/ MCQ) requires a post molding routing step.

Paul recognized that a traditional hook bead style rim was difficult to mold, and that a secondary process would be required. While the routing step achieved the hook configuration, there were numerous short comings to the process, not the least of which was structure characterized by significantly weakened free fiber ends as a result of the router cut.

Figure 11: Impact damage on the right side of the rim in the hook region

Additional short comings are rooted in the fragile nature of the cut carbon fiber ends in compression, and especially impact (Figure 11). The fragile routed hook shape is susceptible to impact (Figure 12), much more so than a closed box section for a composite tubular rim design.

Figure 12: Delamination of the hook region of a composite rim as a result of an impact

As the cut, unsupported hook rim edge impacts a road hazard, the integrity of the tire attachment is at risk-- the tire could suddenly separate from the rim. The VC-1 design eliminates the risk. The very large sides contain four times the amount of -material of a traditional hook-bead clincher rim (carbon or alloy). The Lew Racing Pro VC-1 BSC design relies on a molded shape protected deep in the ID of the rim chamber. This region is guarded from any possible road hazard impact and there are no exposed, weakened cut fibers. The following is a link to a Composites World article describing the routing technique in the Reynolds/ MQC rim. http://www.compositesworld.com/hpc/issues/2006/November/1528

The VC-1 design eliminates the possibility of the tire detaching from the rim unless the tire itself fails. Tire failure in this sense does not refer to punctures, but it refers to complete loss of annular tire structure, so that the tire would no longer remain in an annular form but instead have two disconnected ends.

The strength of the VC-1 mechanical attachment increases as tire pressure increases, forcing the tire bead against the ID of the rim to a more secure position as opposed to forcing the bead outward toward the point detachment from the rim.

A traditional clincher rim-tire interface has a relationship similar to a hook pulling on a rope, specifically the radius of the rim hook which is 1.5 mm (Figure 13). The VC-1 design has a rim-tire interface has a relationship similar to a rope pulled over a large diameter barrel, more specifically the diameter of a bicycle wheel bead seat which is 622 mm, over 414 times larger than the 1.5 mm traditional clincher rim hook bead (Figure 14).

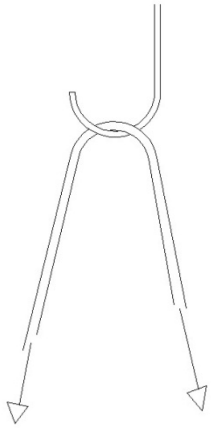

Figure 13: Traditional hook-bead clincher

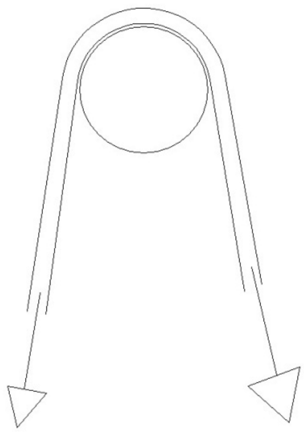

Figure 14: VC-1 Bead-seat clincher

The Lew Racing Pro VC-1 BSC design creates a more stable, less contorted shape between the rim interface and tire interface by exiting the rim in a direction parallel to the side of the rim as opposed to hooking inward, and then outward. This parallel exit reduces the stress applied to the tire, and creates a more favorable tire shape to present to the road, and significantly reduces the possibility of pinching the inner tube, minimizing the possibility of a flat tire.

Photo of BSC rim with tire mounted and rim section

The attached chart appendix (Charts 1-8) explains the tested differences between a hook-bead style carbon composite clincher and the Lew VC-1 BSC specifically pertaining to the effect of heat from brake pad friction and tire pressure.

The tires tested are as follows:

TIRE	MODEL	SIZE
Continental	Grand Prix 4000	23-622
Vittoria	Open Corsa Evo CX	23-622
Schwalbe	Ultremo	23-622
Vredestein	Fortezza Tri Comp	23-622
Specialized	All condition	23-622

Summary of the Tire Chart and Rim Chart

Square shaped beads seat best, and perform above manufacturer's recommended maximum tire pressure (Figure 15) when mounted on the VC-1 BSC.

Figure 15: Square beads, Continental and Vredestein are flat on the bottom, not rounded. The side view shows the flat bottom contour.

Round shaped beads hold firmly up to the manufacturer's recommended tire pressure if care is taken to ensure the tire is precisely concentric to the rim. These tires do not perform safely above the manufacturer's recommended tire pressure (Figure 16) on the VC-1 BSC.

Figure 16: Round Kevlar™ beads Vittoria, Schwalbe, Specialized

Carbon composite hook-bead clinchers suffer from high tire pressure and high heat generated from brake pad friction. These forces result in deformation of the composite resulting in the inability of the rim structure to securely hold the tire. Impact to the carbon composite hook-bead clincher creates the potential for catastrophic structural failure as the cut fibers delaminate and separate, and instantly loose hook-strength to securely hold the tire.

The VC-1 bead-seat clincher design solves these problems associated with composite materials applied to traditional alloy hook-bead clincher design. The result is a safer, lighter, lower inertia solution than traditional hook-bead alloy or composite designs.

Photo of Lew Racing Pro VC-1 Clincher built on Tune Mig 45 Hub, Sapim CX Ray Spokes

TIRE AND RIM CHARTS 1 - 8

CHART 1
LEW BORON CARBON BEAD SEAT CLINCHER TIRE FIT

MODEL	TIRE FIT & EASE OF MOUNTING	MFG. REC. MAX. PRESSURE	FIT & INTEGRITY AT MFG. REC. MAX. PRESSURE	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	FIT & INTEGRITY AT MAX TESTED PRESSURE
Grand Prix 4000	EXCELLENT	120 psi	EXCELLENT	145 psi	EXCELLENT
Open Corsa Evo CX	POOR	145 psi	EXCELLENT	170 psi	EXCELLENT
Ultremo	EXCELLENT	145 psi	FAIR	170 psi	POOR
Fortezza Tri Comp	EXCELLENT	175 psi	EXCELLENT	200 psi	GOOD
All condition	EXCELLENT	125 psi	FAIR	150 psi	POOR

Notes:

One of the tire test specimens resulted in total explosion of the casing after approximately 5 seconds at the over-inflated pressure of 25 psi exceeding manufacturer's recommendation.

Manufactuer's recommended maximum tire pressure should NEVER be exceeded.

In situations such as long descents where high brake track temperatures can elevate tire pressure, the maximum tire pressure prior to beginning the course should be 20 psi (1.5 bar) below the manufacturer's recommended maximum tire pressure.

The Vittoria tire was very tight to mount. The fit was so tight that the test tire was cut off of the rim to remove it.

No other tires presented a challenge to mount or remove

CHART 2
CARBON HOOK BEAD CLINCHER TIRE FIT CHART

MODEL	TIRE FIT & EASE OF MOUNTING	MFG. REC. MAX. PRESSURE	FIT & INTEGRITY AT MFG. REC. MAX. PRESSURE	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	FIT & INTEGRITY AT MAX TESTED PRESSURE
Grand Prix 4000	GOOD	120 psi	GOOD	145 psi	GOOD
Open Corsa Evo CX	GOOD	145 psi	FAIR	170 psi	RIM DAMAGE
Ultremo	GOOD	145 psi	FAIR	170 psi	RIM DAMAGE
Fortezza Tri Comp	GOOD	175 psi	POOR	200 psi	RIM DAMAGE
All condition	GOOD	125 psi	GOOD	150 psi	GOOD

CHART 3
CARBON HOOK BEAD CLINCHER RIM CHART AT 100 DEG F

MODEL	MFG. REC. MAX. PRESSURE	RIM INTEGRITY AT MFG. REC. MAX. PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	120 psi	GOOD	0.000"	NORMAL
Open Corsa Evo CX	145 psi	POOR	0.015"	NORMAL
Ultremo	145 psi	POOR	0.015"	NORMAL
Fortezza Tri Comp	175 psi	POOR	0.050"	RIM FAIL
All condition	125 psi	GOOD	0.000"	NORMAL

MODEL	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	RIM INTEGRITY AT MAX TESTED PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	145 psi	GOOD	0.015"	NORMAL
Open Corsa Evo CX	170 psi	POOR	0.050"	RIM FAIL
Ultremo	170 psi	POOR	0.050"	RIM FAIL
Fortezza Tri Comp	200 psi	FAIL	N/A	RIM FAIL
All condition	150 psi	FAIR	0.030"	BULGING RIM

CHART 4
CARBON HOOK BEAD CLINCHER RIM CHART AT 175 DEG F

MODEL	MFG. REC. MAX. PRESSURE	RIM INTEGRITY AT MFG. REC. MAX. PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	120 psi	GOOD	0.005"	NORMAL
Open Corsa Evo CX	145 psi	POOR	0.025"	RIM NOISE
Ultremo	145 psi	POOR	0.025"	RIM NOISE
Fortezza Tri Comp	175 psi	POOR	0.050"	RIM FAIL
All condition	125 psi	GOOD	0.005"	NORMAL

MODEL	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	RIM INTEGRITY AT MAX TESTED PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	145 psi	GOOD	0.015"	NORMAL
Open Corsa Evo CX	170 psi	FAIL	0.150"	RIM FAIL
Ultremo	170 psi	FAIL	0.150"	RIM FAIL
Fortezza Tri Comp	200 psi	FAIL	N/A	RIM FAIL
All condition	150 psi	POOR	0.100"	RIM FAIL

CHART 5
CARBON HOOK BEAD CLINCHER RIM CHART AT 250 DEG F

MODEL	MFG. REC. MAX. PRESSURE	RIM INTEGRITY AT MFG. REC. MAX. PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	120 psi	GOOD	0.100"	RIM FAIL
Open Corsa Evo CX	145 psi	POOR	0.150"	RIM FAIL
Ultremo	145 psi	POOR	0.150"	RIM FAIL
Fortezza Tri Comp	175 psi	POOR	N/A	RIM FAIL
All condition	125 psi	GOOD	0.100"	RIM FAIL

MODEL	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	RIM INTEGRITY AT MAX TESTED PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	145 psi	FAIL	N/A	RIM FAIL
Open Corsa Evo CX	170 psi	FAIL	N/A	RIM FAIL
Ultremo	170 psi	FAIL	N/A	RIM FAIL
Fortezza Tri Comp	200 psi	FAIL	N/A	RIM FAIL
All condition	150 psi	FAIL	N/A	RIM FAIL

CHART 6
LEW BORON CARBON BEAD SEAT CLINCHER RIM CHART AT 100 DEG F

MODEL	MFG. REC. MAX. PRESSURE	RIM INTEGRITY AT MFG. REC. MAX. PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	120 psi	GOOD	0.000"	NORMAL
Open Corsa Evo CX	145 psi	GOOD	0.000"	NORMAL
Ultremo	145 psi	GOOD	0.000"	NORMAL
Fortezza Tri Comp	175 psi	GOOD	0.000"	NORMAL
All condition	125 psi	GOOD	0.000"	NORMAL

MODEL	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	RIM INTEGRITY AT MAX TESTED PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	145 psi	GOOD	0.000"	NORMAL
Open Corsa Evo CX	170 psi	GOOD	0.000"	NORMAL
Ultremo	170 psi	GOOD	0.000"	NORMAL
Fortezza Tri Comp	200 psi	GOOD	0.000"	NORMAL
All condition	150 psi	GOOD	0.000"	NORMAL

CHART 7
LEW BORON CARBON BEAD SEAT CLINCHER RIM CHART AT 175 DEG F

MODEL	MFG. REC. MAX. PRESSURE	RIM INTEGRITY AT MFG. REC. MAX. PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	120 psi	GOOD	0.000"	NORMAL
Open Corsa Evo CX	145 psi	GOOD	0.000"	NORMAL
Ultremo	145 psi	GOOD	0.000"	NORMAL
Fortezza Tri Comp	175 psi	GOOD	0.000"	NORMAL
All condition	125 psi	GOOD	0.000"	NORMAL

MODEL	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	RIM INTEGRITY AT MAX TESTED PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	145 psi	GOOD	0.000"	NORMAL
Open Corsa Evo CX	170 psi	GOOD	0.000"	NORMAL
Ultremo	170 psi	GOOD	0.000"	NORMAL
Fortezza Tri Comp	200 psi	GOOD	0.000"	NORMAL
All condition	150 psi	GOOD	0.000"	NORMAL

CHART 8*
LEW BORON CARBON BEAD SEAT CLINCHER RIM CHART AT 250 DEG F

MODEL	MFG. REC. MAX. PRESSURE	RIM INTEGRITY AT MFG. REC. MAX. PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	120 psi	GOOD	0.000"	NORMAL
Open Corsa Evo CX	145 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH
Ultremo	145 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH
Fortezza Tri Comp	175 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH
All condition	125 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH

MODEL	MAX. TESTED PRESSURE EXCEEDING MFG. REC.	RIM INTEGRITY AT MAX TESTED PRESSURE	DIMENSIONAL CHANGE RIM WIDTH	DESCRIPTION
Grand Prix 4000	145 psi	GOOD	0.000"	NORMAL
Open Corsa Evo CX	170 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH
Ultremo	170 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH
Fortezza Tri Comp	200 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH
All condition	150 psi	GOOD	0.000"	POOR TIRE CASING STRENGTH

*Due to the temperature, tire security is challenged. The tires remained attached to the rim with no rim damage.