STRESSHEAD Ltd
INNOVATIVE STRENGTHENING OF STRUCTURES

Increase shear capacity

Silo strengthening

Strengthening of structures with posttensioned CFRP loops
Tensioning system StressHead® CL-RESTRAP

Shear strengthening of beams and joists
External post-tensioning of Silos – Watertanks – Chimneys

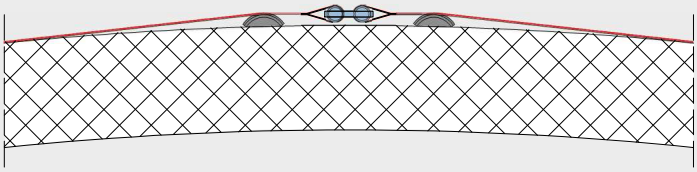
Structural strengthening with tensioned CFRP loops

StressHead® CL-RESTRAP is an external posttensioning system made of carbon fiber reinforced plastic (CFRP) tapes that are wound endlessly into a loop. The use of thin, multilayer tapes allows very small bending radii.

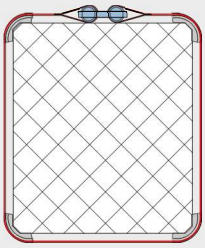
The loops can be produced in any length and dimension, have excellent long-term behaviour and are easy to assemble by hand due to their feather-light weight.

Typical usage

- Shear strengthening of beams and joists
- External post-tensioning of Silos – Watertanks – Chimneys



Ex. Compression ring around a Silo / Tank / Chimney



Ex. Shear strengthening

Advantages

- Outstanding material behaviour related to fatigue and relaxation
- Large tensioning-elongation ($\varepsilon_{P0} \approx 6.3‰$), small tensioning losses with concrete creep
- Active tensioning system simple calculation
- Feather-light system
- Easy handling and installation
- Low space requirement
- No corrosion and chemical resistant
- Loop dimension variable

Tensioning system StressHead® CL-RESTRAP

A standard CL-RESTRAP loop is designated according to its posttensioning force. The associated ultimate loads and posttensioning forces are defined in the table below. It should be noted that the posttensioning force can be doubled in the case of shear reinforcement due to both-sided installation.

Name	Ultimate Load [kN]	Tensioning force [kN]	Wide [mm]	Thick [mm]	EA [MN]	Weight [g/m]	Elongation [mm/m]
CL-RESTRAP …	*Larger dimensions are fabricated on request project specific*						
CL-RESTRAP 100	200	100	25.4	3.8	15.68	144	6.4
CL-RESTRAP 90	180	90	25.4	3.6	14.70	135	6.1
CL-RESTRAP 80	160	80	25.4	3.1	12.74	117	6.3
CL-RESTRAP 70	140	70	25.4	2.6	10.78	99	6.5
CL-RESTRAP 60	120	60	25.4	2.4	9.80	90	6.1
CL-RESTRAP 50	100	50	25.4	1.9	7.84	72	6.4

Tab 1: Dimensions and posttensioning forces. Other dimensions available on request.

STRESSHEAD AG
INNOVATIVE BAUWERKSVERSTÄRKUNG

Application CL-RESTRAP

The posttensioning system is tensioned like a tension belt around the element to be reinforced. In the case of small radii, it is pulled around deflection saddles. Bolts are placed in the ends of the loops, which are tightened and locked using hydraulic clamping pliers. The loop is thereby pretensioned.

Detail loop

Mockup, detail bolts

Tensioning process with clamping plier

Principle of the shear strenghtening

The tensioning system strengthens the concrete beam in all **4 factors** that affect the shear strength of concrete beams:

- Due to the looping effect of the CL-RESTRAP system, the missing cross-section is added to the stirrup reinforcement by means of CFRP. Furthermore, the prestressing improves the bond between concrete and existing reinforcement.
- The multiaxial stress state achieved by the prestressing in the concrete increases the strength of the concrete in compression.
- The additional reinforcements at regular intervals shorten the free length of the longitudinal reinforcement and improve the dowel action.
- The prestressing reduces the crack width, which means that the interlocking of the aggregates in the concrete is also improved.

Calculation of the shear strengthening

The entire shear force that cannot be transferred by existing reinforcement is to be absorbed by the posttensioning in the CL-RESTRAP system. Compared to bonded reinforcement, posttensioning has the advantage that the shear force is absorbed directly by the CL-RESTRAP's without the need for further deformation. On the other hand, the existing cracks are closed.

The CL-RESTRAP system can be individually adapted to the construction project in terms of length and pretensioning force.

$$V_{d,s} = V_d \cdot s \div z$$

$V_{d,s}$ = *Erforderlicher Widerstand des CL-RESTRAP (2-schnittig)*
V_d = *Shear force that cannot be absorbed by existing reinforcement*
s = *Spacing CL-RESTRAP's*
z = *Inner distance between compression and tension belt (norm. 0.9h)*
h = *Height of the beam*

Based on $V_{d,s}$ a CL-RESTRAP can be chosen acc. *Tab. 1*

Translated from Norm SIA 166:2004

3.1.7.3.4 If a bending girder is to be reinforced for shear force that already exhibits shear cracks in the unreinforced service condition, stirrups that enclose the entire height of the girder and can be prestressed must be used. The adhesive effect therefore has only a constructive character.

Further Information

StressHead Ltd
Leumattstrasse 33
CH-6006 Luzern
P +41 41 210 40 30

stresshead@stresshead.ch