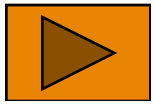
Lokset® Resin Capsules

User's Information Pack

Click here for instructions



Click on the Task Desired

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RESIN BOLTING BASICS

PLANNING RESIN ROCK BOLTING

RESIN INSTALLATION GUIDE

RESIN STORAGE & HANDLING

RESIN TROUBLESHOOTING AID

Click Here to Exit

Instructions

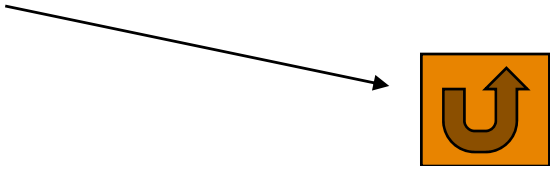
This Information Pack is to assist users of Lokset® Resin capsules in obtaining the maximum safety, economy and reliability in resin roofbolting. It contains information on handling and storage, installation practice and troubleshooting typical problems.

The Information Pack requires Windows and a mouse. Use the mouse to move between slides. Clicking on underlined text opens a new slide, with more information. Clicking on  will return you to the previous slide. Clicking on  will advance you to the next slide.

Click here to return 

This was a demonstration of how to open a new slide containing additional information.

Click here to return



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Version	2.3
Date	1999, 2002, 2003, 2010
Author	D. O'Connor

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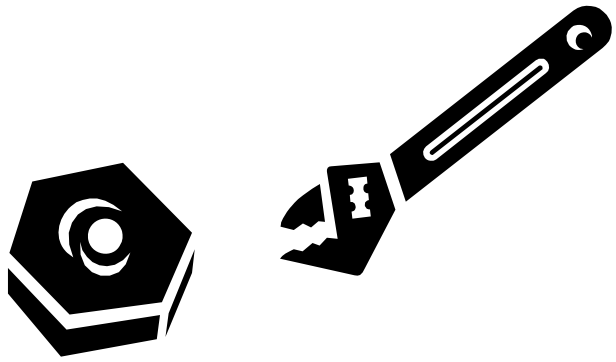
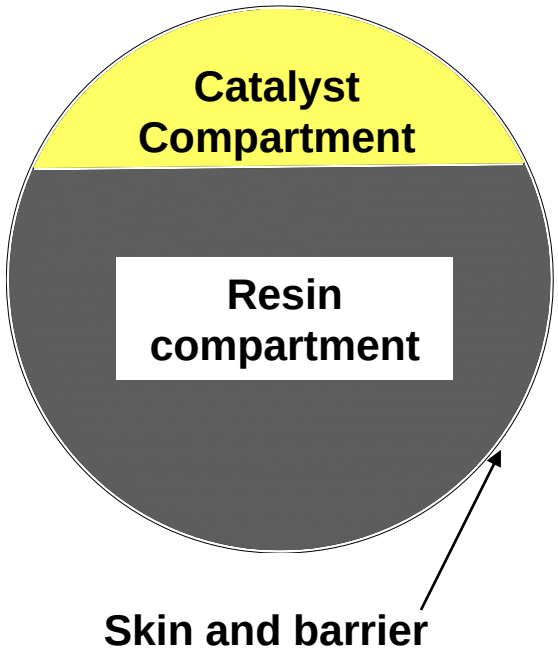
Resin Roofbolting Basics



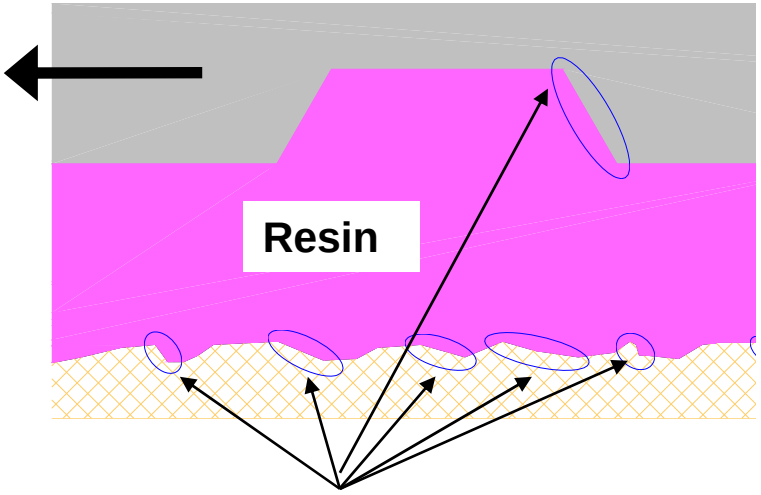
What is a Resin Capsule ?



A resin capsule is a two-compartment tube containing a polyester resin composition in one compartment and a catalyst composition in the other. When the capsule is used the separation between the two compartments is broken and the the two compositions are mixed together. The catalyst causes the resin to harden at a controlled and pre-selected speed. The hardened resin securely anchors the rock bolt into the hole, strengthening the rock

The skin or sheath of the capsule is a special plastic which is strong enough to contain and protect the contents during manufacturing, storage and handling, yet breaks up easily in the rock bolt hole, to completely release the two components and not interfere with the contact between the set resin and the rock or the rock bolt.

What Does the Resin Do ?



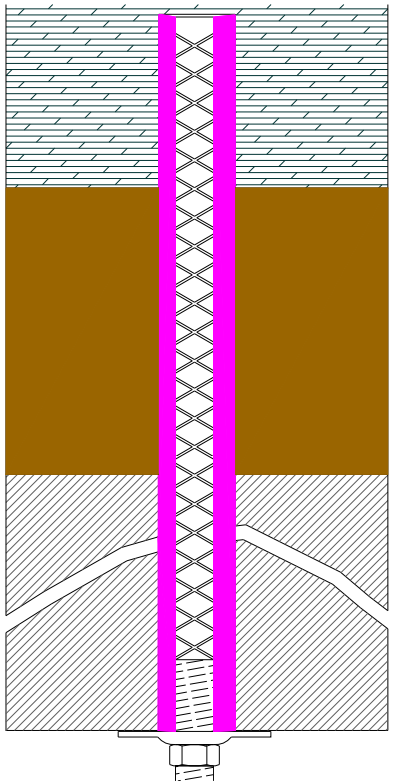
Resistance zones

The hardened resin is a high-strength grout which completely fills the gap between the rock bolt and the rock, securely bonding the bolt into the hole.

It is the rock bolt which strengthens the rock - the function of the resin is to transmit stresses between the rock and the rock bolt, without allowing the rock bolt to move. The resin does this by filling all irregularities on the surfaces of the rock and the bolt. The two surfaces therefore cannot slide past each other, nor can the rock close in towards the bar. The rock is effectively locked into place by the resin and rock bolt combination.

Resin is **not a glue** - if the two surfaces are pulled away from each other, the resin will offer relatively little resistance.

How do Rockbolts Work ?



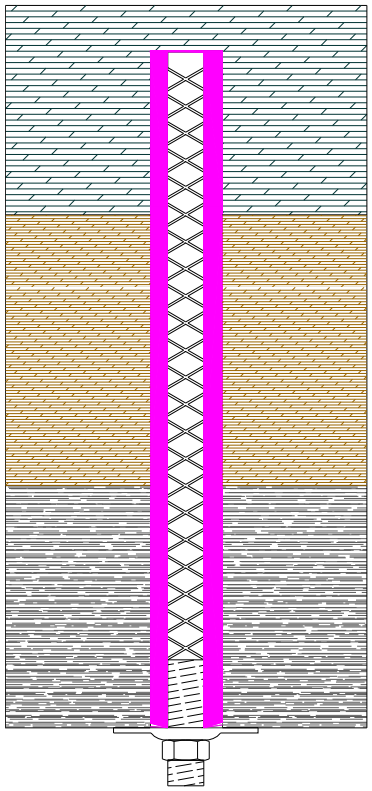
Suspension

Rock bolts have proven highly effective in stabilising the rock around underground excavations. This contributes to safety and productivity.

Rock bolts act in two ways:

•**Suspending blocks** of rock that have come loose from the sides or roof of the excavation. This reduces the hazard of rock falls but does little to prevent further deterioration of the rock.

•**Clamping the rock together**, restraining the rock from shearing under the stresses in the roof. Clamping makes more effective use of the strength of the rock bolt and should be the objective of a well designed rock bolting system. While providing clamping, the rock bolts will also suspend any blocks that do become loose.



Clamping

Resin Rock Bolting Practice

There are three common methods of resin roofbolting. Click on the titles below for more information on each

- End-anchored bolting
- Full-column resin bolting
- Tensioned full-column resin bolting

Critical Issues for Success

- **Effective resin rock bolting requires attention to the details of:**
  - Rock bolt selection - type and size
  - Hole drilling
  - Resin selection – strength grade, speed and size
  - Installation equipment
  - Operator knowledge and proficiency

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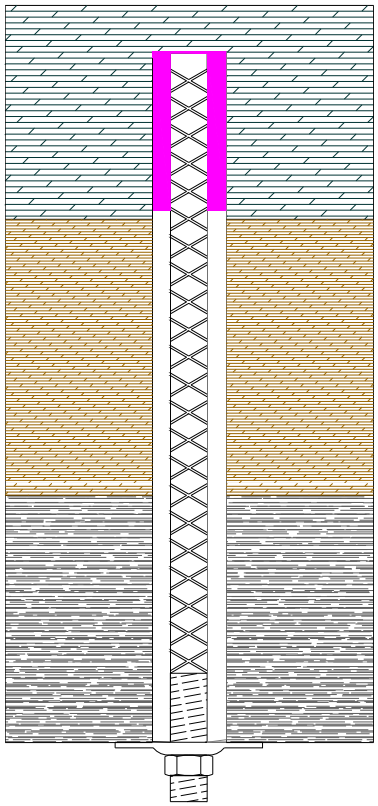
End-anchored Bolting



Resin is used to anchor the end portion of the bolt into the hole. The bolt is then tensioned, clamping the rock together.

Advantages

•Simple and easy to install, by hand or machine

•Cheap

Disadvantages

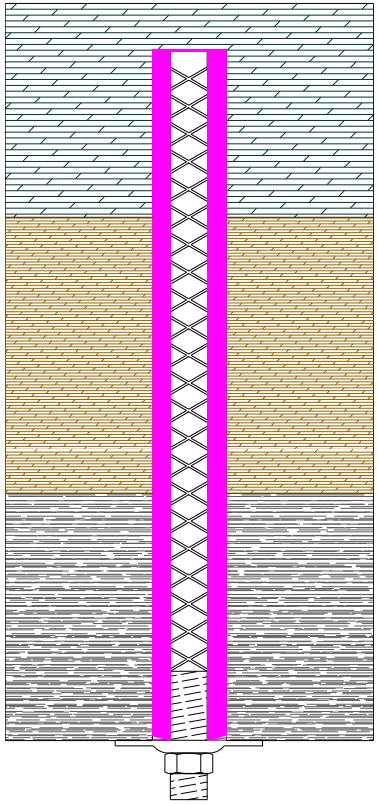
•Loses effectiveness when tension is lost through creep or frittering away of the rock at the mouth of the hole

•Clamping effect is not strong

•Bolt is exposed to corrosion

•Requires competent anchoring layer (at least 500 mm recommended)

Full-column resin bolting



The full volume between the rock bolt and the rock is filled with resin. The bolt does not have to be tensioned, although this is usually done when threaded bolts are used.

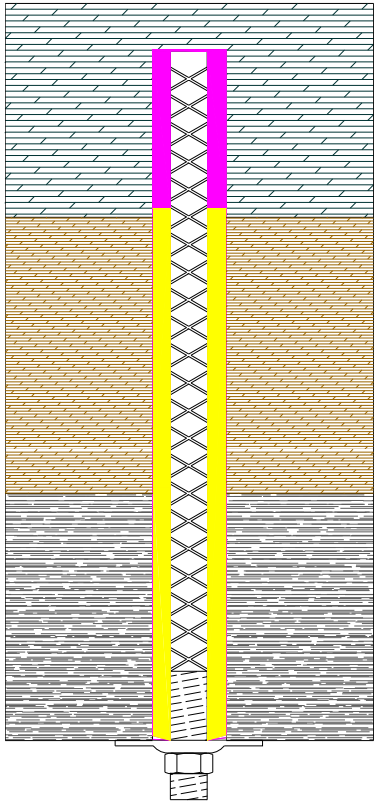
Advantages

- Stiff, highly effective suspension and clamping effects
- Retains effectiveness
- Does not require competent anchoring layer
- Bolt is protected from corrosion

Disadvantages

- Requires high thrust and torque to install
- Installation timing critical to ensure mixing at top while avoiding over mixing at collar
- More expensive

Tensioned Full-column Bolting



Fast-set resin is used at the back of the hole, with the rest of the column filled with slower-setting resin. The bolt is tensioned before the slower resin sets.

Advantages

- All of the advantages of full-column resin bolting
- Enhanced stiffness
- More flexible installation timing - fast resin can be fully spun without over-spinning slow resin
- Can be combined in one Two-Speed capsule

Disadvantages

- Operator discipline required to insert the fast capsule first.

What Does Water Do ?

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Pro's

- Expands on setting - gives better key onto rock
- High pull-out stiffness
- Reduces cost

Con's

- Cannot achieve the very highest strengths

Resin Compartment

Material	%
“Resin”	15 - 30
Limestone filler	70 - 85
Dyes etc	0 - 1

Catalyst Compartment

Material	%
Benzoyl Peroxide	2 – 6
Limestone	0 - 95
Water or Oil	0 - 25
Dyes etc	0 - 1

Planning Resin Rock Bolting

Factors to Consider ...

- **Design objective of the rock bolt support -** this includes the loads to be carried, the maximum design deflections, the volume of rock to be reinforced and the contribution of other support such as meshing and lacing. The design must be made in the context of the expected rock properties (strength, density, degree of fracturing etc.) and the stress field. The design objective is the major influence on the specification of the strength, size, number and placement of the bolts and the strength of the resin grout.

- **Mining environment -** the size of the excavation, services (air, water, electric power) available, integration of the rock bolting operation with the other operations in the mining cycle and the skill level and availability of personnel for rock bolting. Logistical factors such as transport distance and mode may also affect choice of packaging.

Factors to Consider ...

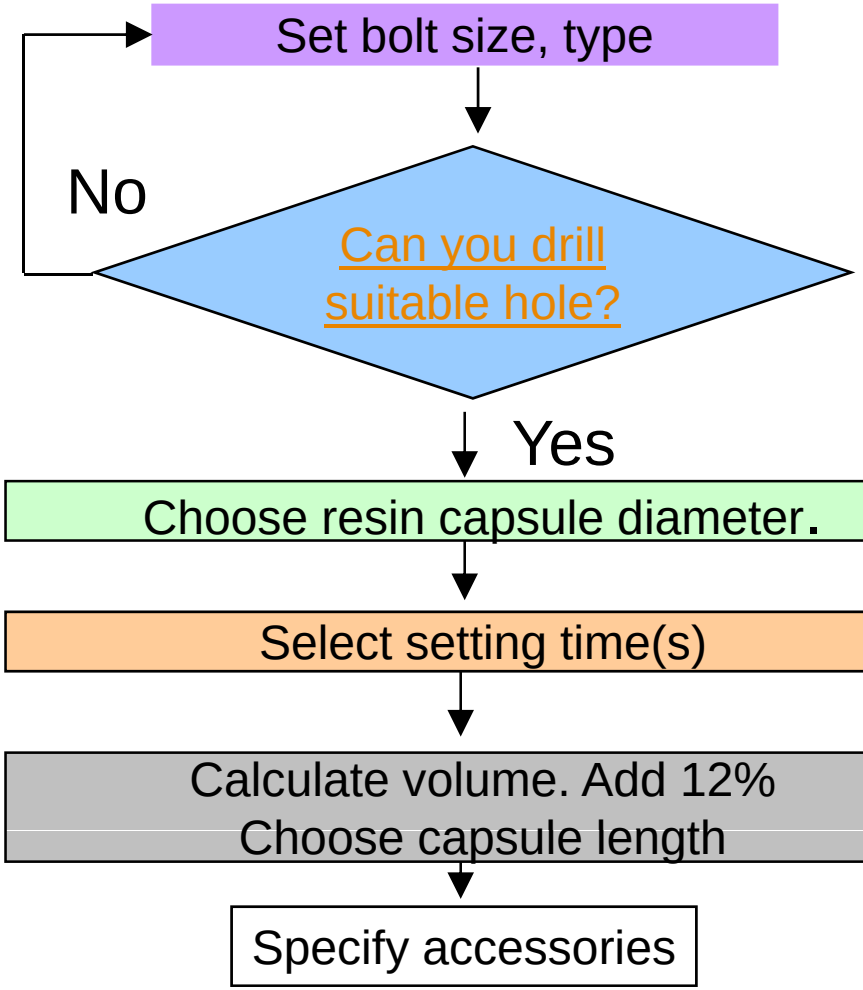
- **Drilling and installation equipment available** - this must be considered in relation to the desired size of the bolts, as the size of the resin-filled annulus around the bolt is the major influence on the consumption of resin and on the ability to insert the bolt and adequately mix the resin. The installation equipment must include means of loading the resin capsules and of thrusting, spinning and tightening the bolt in the required direction.

- **The bolt** - this must provide the strength called for in the design specification and have surface deformations compatible with the properties of the resin. If a new shape of deformation is being considered, compatibility tests should be performed. When installing continuously threaded bolts (e.g. Gewi), the bolt must be spun in the direction which pushes the resin to the back of the hole.

Factors to Consider ...

- When planning a new resin bolting system it is best to consider all these factors together so that the elements of the system are fully compatible. The following pages provide a method for systematic analysis.

Planning Steps



Rock mechanics engineer's input

See tables of hole, bolt, capsule diameters

See tables of hole, bolt, capsule diameters

See guide

Use resin calculator

Recommended Systems - Coal

Bolt	Capsule diameter (mm)			
	19	21	23	25
16 mm				
18 mm				
20 mm				
	22-24	23-26	25-28	27-32
Good		Hole diameter (mm)		

For air-loading, use next smaller diameter

Recommended Systems - Hard Rock

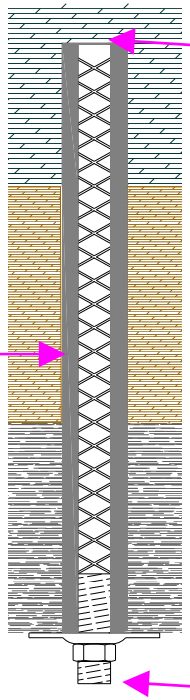
Bolt (mm)	Capsule diameter (mm)			
	25	28	32	35
20				
25				?
32				
	27-32	30 - 36	34-40	37-42
Good		Hole diameter (mm)		

Use dark-shaded combinations with caution. For air-loading, use next small diameter.

Setting Time Selection Guide

	Temperature <25°C		Temperature > 25°C	
	High-speed bolter	**Jackhammer**	**High-speed bolter**	**Jackhammer**
Untensioned bolts	30s	60s	60s	60s
Tensioned bolts	30s + 120s or 5/10 m	60s + 5/10 min	60s + 5/10 min	60s + 5/10 min
Spin-to-stall	15s (+ 120s or 5/10)	-	20s (+ 5/10 min)	20s (+5/10)

Hole Depth and Diameter



Hole depth 50 mm < total bar length

Best - Hole diameter 5 – 10 mm more than bar diameter

DO NOT OVERDRILL !

20 mm thread below nut

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Lokset® Resin Bolt System

Installation Guide

Safety

- Work under supported roof
- Wear goggles
- Wear gloves
- Do not use resin near flame or sparks
- Avoid contact with the capsule contents
- Read Material Safety Data Sheet

Equipment

- DRILL BITS - correct size
- BOLT - correct diameter and length
- RESIN CAPSULES – correct strength grade, diameter, working time, length
- INSTALLATION SPANNER
- ROOFBOLTER or AUTOROCK DRILL RIG

Recommended Systems - Coal

Bolt	Capsule diameter (mm)			
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16 mm				
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25				?
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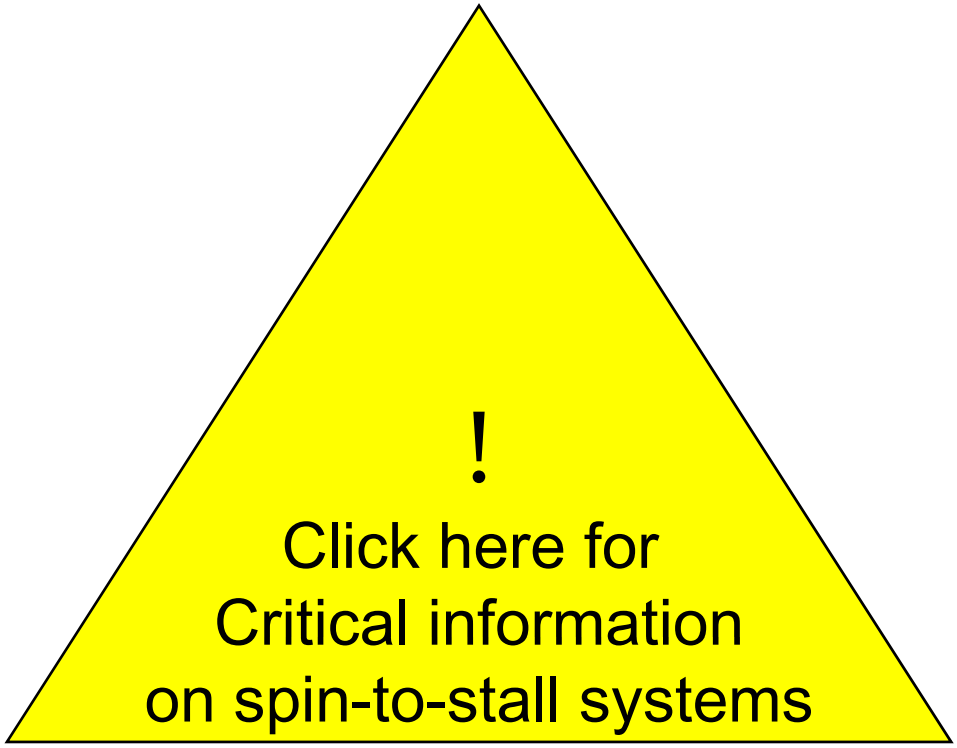
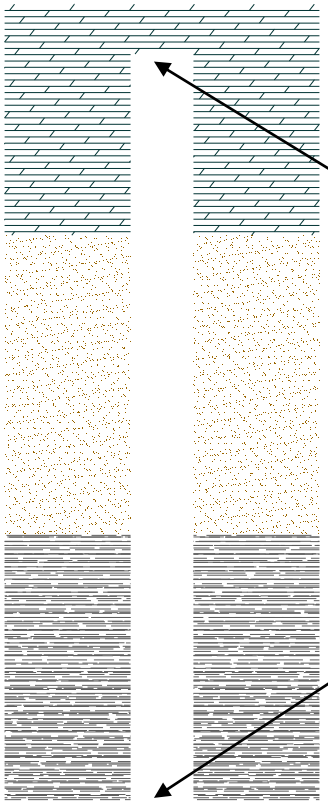
Spin-to-stall ?



Drill the Hole



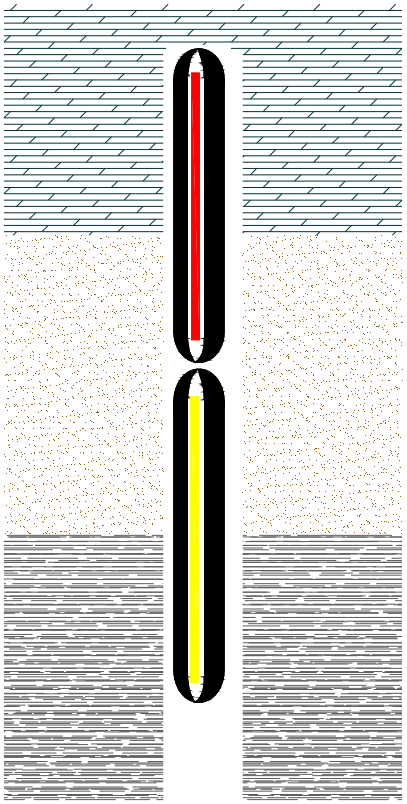
CHECK -

Depth

Diameter

[More information on depth and diameter]

Insert Resin Capsules



Always insert in the correct order -

- **Purple**
- **Red**
- **Green**
- **Blue**
- **Yellow**

2-speedie capsule – insert purple / red end first

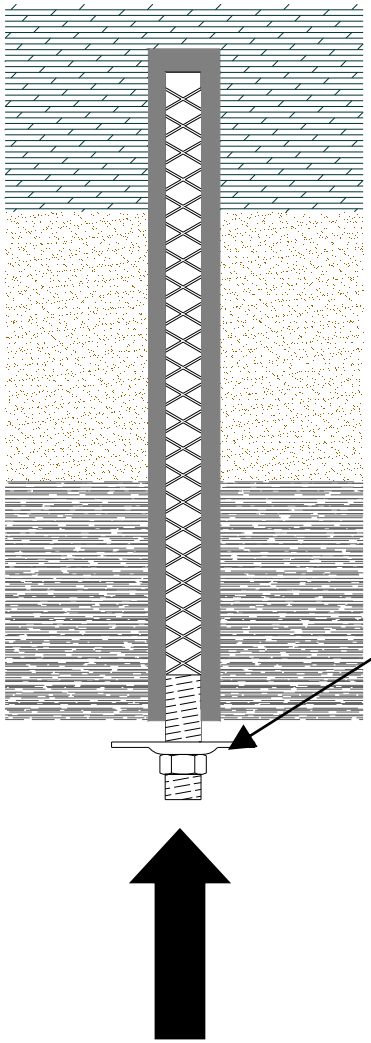
What do these colours mean ?

Resin Colour Codes

Colour	Working Time
Purple	15 seconds
Red	30 seconds
Green	60 seconds
Blue	120 seconds
Yellow	5 minutes

Working Time **is the time taken by the resin to set hard enough to hold the bolt.**

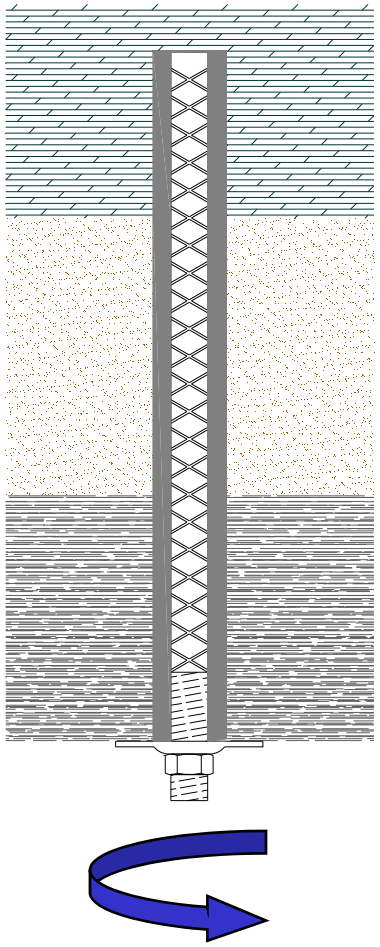
Insert Bolt



Push the bolt into the hole, until the plate is just below the roof

Should I spin the bolt while pushing ?

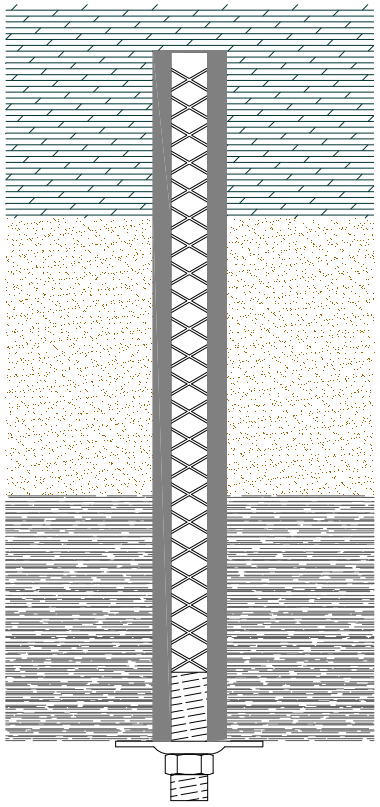
Spin The Bolt



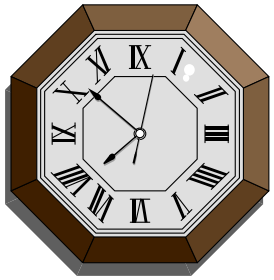
- **Spin the bolt for the recommended spin time.** **Spin for at least 3 seconds with the bolt at the top of the hole !**
- **Then push upwards with maximum force.**

Tell me why spinning is important

Wait...



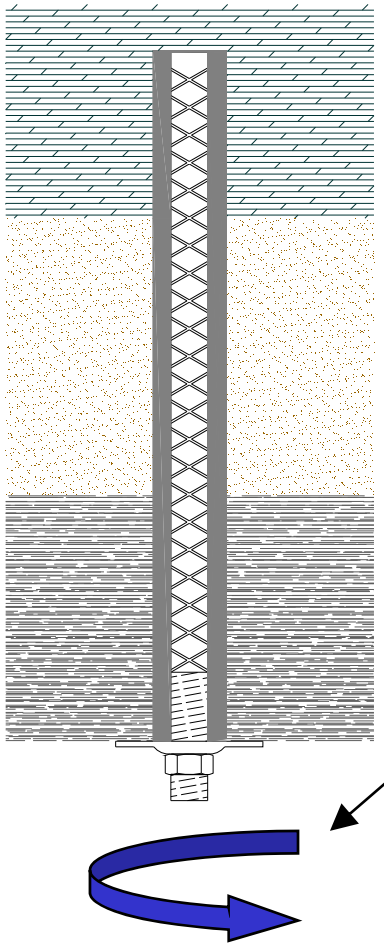
Wait for the recommended Hold Time



Show me the Hold Times

What about two-speed systems ?

Tighten Nut



Wait the full Hold Time !

Tighten the nut until the machine stalls

What happens if the wait is too short ?

For More Information -

- See box labels
- Contact Minova RSA
  - Tel: (+2711) 923 1900
  - Fax: (+2711) 392 3479
  - e-mail: inforsa@minovaint.com

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Resin Capsule Strength Grade

- **Lokset resin capsules are available in two strength grades:**
  - Lokset standard: shear strength – 19 MPa
    - General use; as slow component of 2-speed systems
  - Lokset A: shear strength – 25 MPa
    - Stiff systems; as suspension element in strata with RD > 3.0

Recommended Systems - Coal

Bolt	Capsule diameter (mm)			
	19	21	23	25
16 mm				
18 mm				
20 mm				
	22-24	23-26	25-28	27-32
Good		Hole diameter (mm)		

For air-loading, use next smaller diameter

Recommended Systems - Hard Rock

Bolt (mm)	Capsule diameter (mm)			
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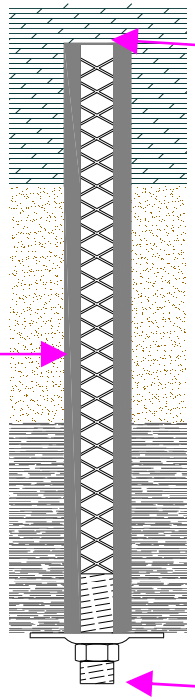
20				
25				?
32				
	27-32	30 - 36	34-40	37-42
Good		Hole diameter (mm)		

Use dark-shaded combinations with caution. For air-loading, use next small diameter.

Hole Depth and Diameter



Hole depth 50 mm < total bar length

Hole diameter 5 - 10 mm more than bar diameter

DO NOT OVERDRILL !

20 mm thread below nut

Resin Colour Codes

Colour	Working Time
Purple	15 seconds
Red	30 seconds
Green	60 seconds
Blue	120 seconds
Yellow	5 minutes

Working Time **is the time taken by the resin to set hard enough to hold the bolt.**

What Does This Mean ?

Lokset resin capsules conform to South African standard SABS 1534-1991. The SABS 1534 standard lays down minimum performance requirements for resin capsules. It also sets out precise definitions for commonly-used terms. These definitions are:

- **Spin time** - the period for which the resin in a capsule should be spun to ensure proper mixing of the constituent components.
- **Hold time** - the period after spin time, during which disturbance of the resin can lead to irreparable loss of setting strength of the resin.
- **Working time** - the sum of spin time and hold time.
- **Set time** - the time taken (from the onset of mixing) for the mixture to set, i.e., when solidification occurs. [this is mainly of interest in laboratory testing]

Recommended Spin Times

Colour Code	Spin Time
Purple	3 seconds
Red	10 seconds
Green	15 seconds
Blue	15 seconds
Yellow	20 seconds

Click here for more information on spin times

Spin During Bolt Insertion ?

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This is optional

- **When is it beneficial**
  - If it is difficult to push the bar through the resin, spinning will help
- **When is it harmful**
  - If the bar is spun longer than the specified spin time

More About Spin Times

- **What rotation speed should be used**
  - The ideal rotation speed is 250 - 750 rpm
  - High rotation speed shortens set time. Test on site for best spin time if speed is over 400 rpm
- **What about using a jackhammer**
  - Use a slower resin, usually 60 s (green)
  - Spin for 40 - 60 revolutions
- **In a two-speed system, which working time determines the spin time**
  - The shorter spin time must be used

The Importance of Spinning

- **What does spinning do ?**
  - Spinning breaks the skin of the capsules, releasing the resin and catalyst and mixing them together. The catalyst makes the resin start setting.
- **What if the bolt is not spun enough ?**
  - The resin and catalyst will not mix properly. The resin will not set hard. The bolt is ineffective.
- **What if spinning carries on too long ?**
  - The partially-set resin is broken up. It is crumbly and too weak to be effective.

Hold Times at 20°c

Colour Code	Working Time	Hold Time
Purple	15 s	10 seconds
Red	30 s	20 seconds
Green	60 s	45 seconds
Blue	120 s	120 seconds
Yellow	5 min.	10 minutes

Click Here For Hold Times At Cold Temperatures

Hold Times at Cold Temperatures

- Lokset® Resin capsules require longer hold times when the temperature is below 20°C. Use the tables below for the hold times needed.

30 s Resin

60 s Resin

30 Second Resin - Low Temperature

Temperature of Capsules (°C)	Hold Time (seconds)
18	25
16	30
14	35
12	50

60 Second Resin - Low Temperature

Temperature of Capsules (°C)	Hold Time (seconds)
18	50
16	55
14	60
12	75

Two-speed Systems

- **The Hold Time for a two-speed system is the Hold Time for the faster resin**
- **e.g., for a 30 s (red) and 5 minute (yellow) system -**
  - Red hold time = 20 s
  - Yellow hold time = 10 minutes
  - Use 20 s hold time (or longer)
- **For best results, do not exceed the hold time for the slower capsule**

Tightening Too Early

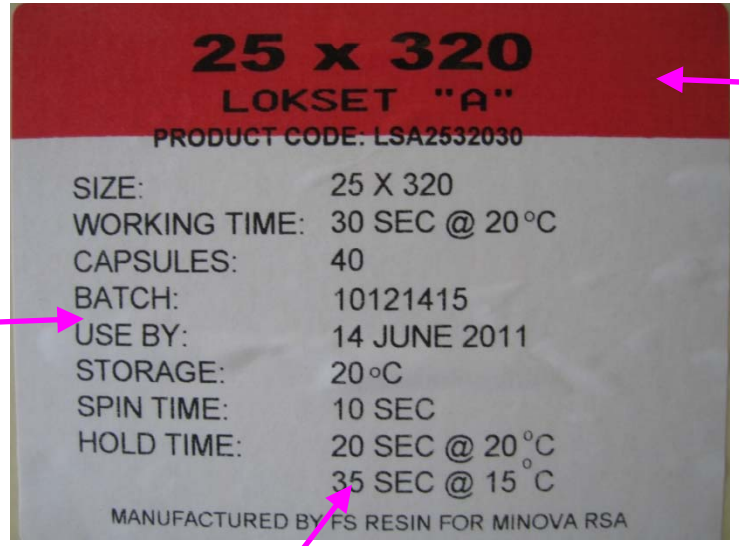
- The turning will break the partially-set resin.
- You will see a long “tail” of thread underneath the nut.
- The roofbolt will not give the support required - ***it has been wasted !***
- Another bolt must be installed.

Roofbolter Torque Settings

Roofbolter torque should be set at 230 - 250 Nm for most applications. ***This setting is important*** for good roofbolting and should be checked regularly, according to mine procedures. The torque setting should be:

- High enough to spin the bolt, break the shear pin (if a shear pin nut is used) and tension the bolt.
- Not so high that it strips the threads or breaks the bar by twisting it off.

Lokset® Box Label Explained



Colour code for Working time

Batch No. and "use-by" date

Recommended spin and hold times at 20°C

Spin-to-stall Installations

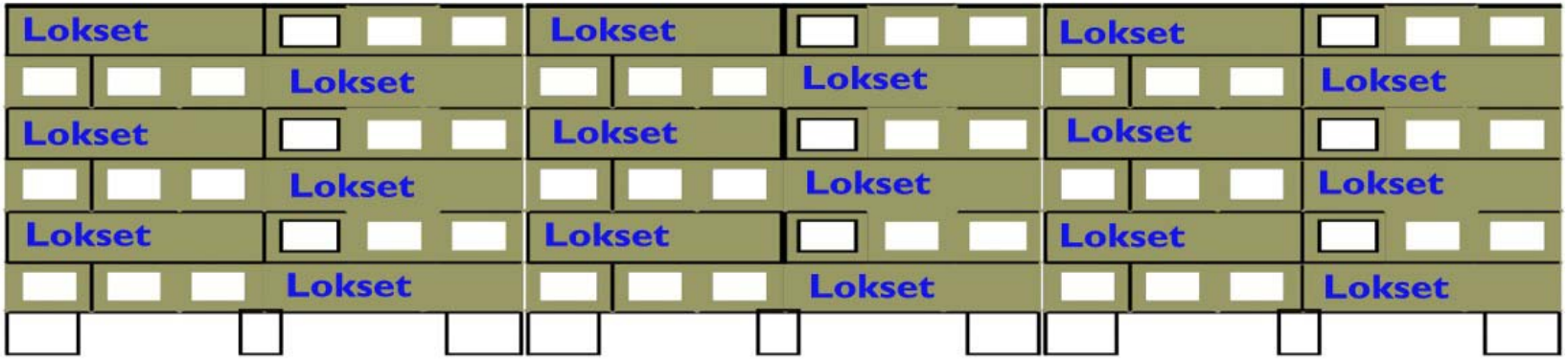
- Spin-to-stall installations must be planned and approved for use.
- The Rock Mechanics Engineer, bolt supplier and resin supplier must coordinate requirements so compatible materials are supplied, and used as designed.
- Tests must be done to verify performance of the system.

Key Parameters

- **Resin –**
  - 15 s setting time for coal (code: Purple)
  - 20 s setting time for hard rock (code: Black)
- **Nut – consistent, planned breakout**
- **Bolt / hole – consistent, planned diameter**
- **Bolter – consistent speed and thrust**
  - Torque limited to 250 N-m

Spin-to-stall procedure

- Drill hole
- Insert resin capsule (s)
- Insert bar
- Spin until the shear pin breaks
- Continue spinning till bolter stalls
- Check the installed bolt
- Re-bolt if the bolter does not stall or too much thread shows



Storage And Handling

Objectives

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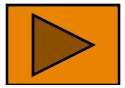
- **SAFETY**
  - Minimise risks of -
    - Fire
    - Health
    - Pollution
- **Economy**
  - Reduce damage and deterioration



Safety and Health

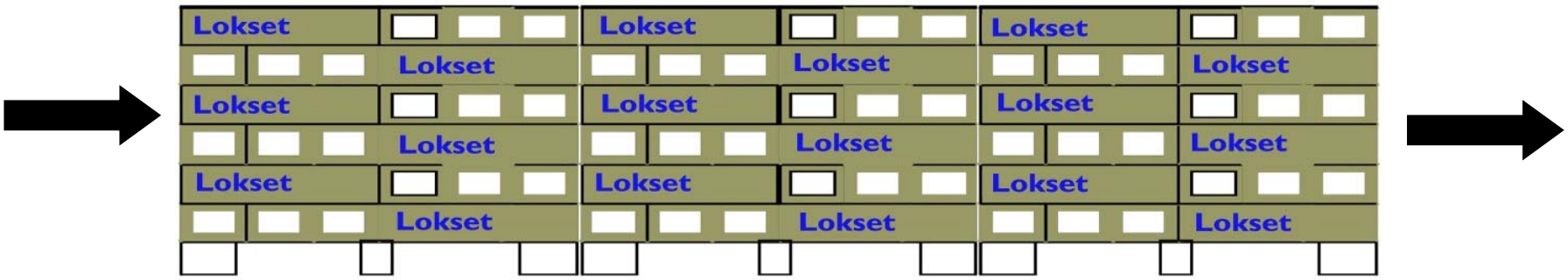
- No smoking
- Shield from flame or heat
- Ensure racking carries pallet weight
- Do not store with acids, flammables or food
- Ventilate store - avoid styrene build-up
- Read Material Safety Data Sheets

Packaging and Delivery

- **Normal packaging**
  - Waxed cardboard boxes, on pallets
- **Special packaging**
  - Buckets, for shaft-sinking
  - Stretch-wrapped pallets
  - Containerised

Storage Guidelines

- Store in a cool, dry, well ventilated place



- Issue stock “first in, first out”
- Observe “use by” date

“Use By” Date

- **6 or 4 months from manufacture**
  - 4 months for capsules > 600 mm
- **Storage at 20°c**
- **For more information, click …**

Storage at other temperatures	**Where to find “use by” date**
What happens when resin ages	**What to do with expired product**

Resin Capsule Ageing

- Capsules become limp - more difficult to use
- Resin and catalyst pastes harden - more difficult to insert bolt

After "use by" date -

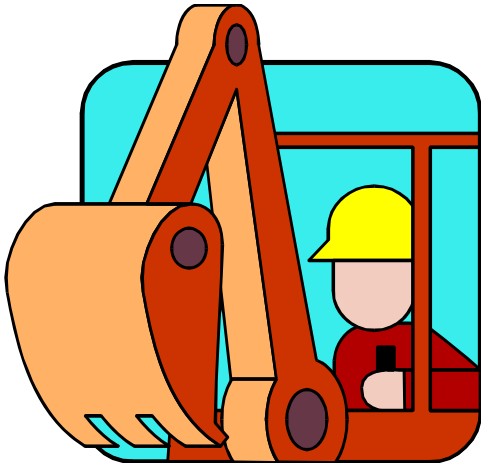
- Setting time slows
- Strength reduces

Capsules Past “Use By” Date ?

- Contact Minova RSA - depending on our tests it may be possible to extend “use by”, or -
- Dispose, in accordance with regulations

Disposal

- By licensed contractor only
- Land filling is best
- Prevent groundwater pollution

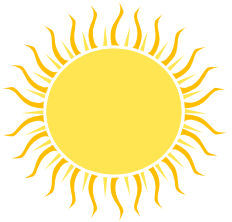


Contact Minova RSA

- Telephone (+2711) 923 1900
- Fax (+2711) 923 1935
- e-mail rsamarketing@minovaint.com
- Post P.O. Box 52,
  Isando,
  1600,
  South Africa

High/low Temperature Storage

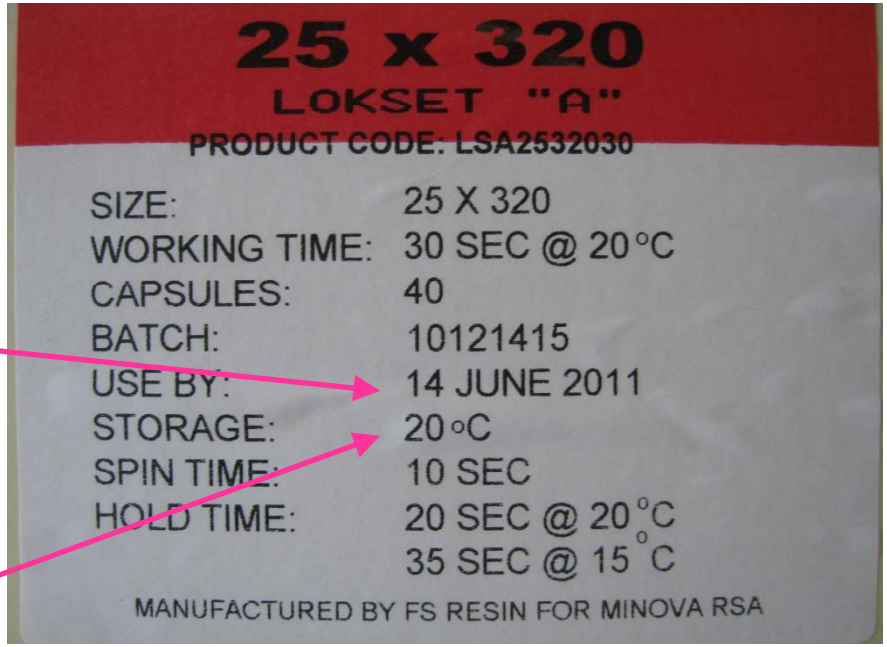
- **High temperature**
  - Shelf life reduced
  - Consider refrigerated store
- **Low temperature**
  - Shelf life increased
  - Do not allow capsules to freeze
  - Warm to 10°c before use



More on temperature

More on storage underground

Lokset® Box Label

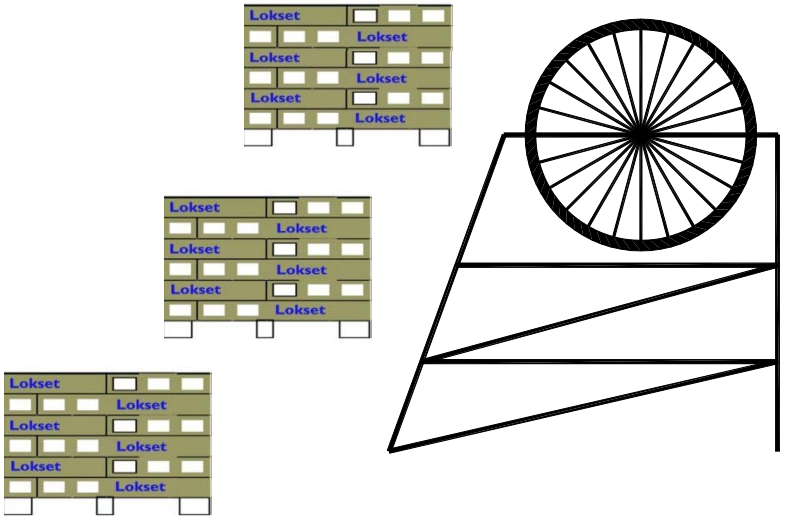


"Use by" date

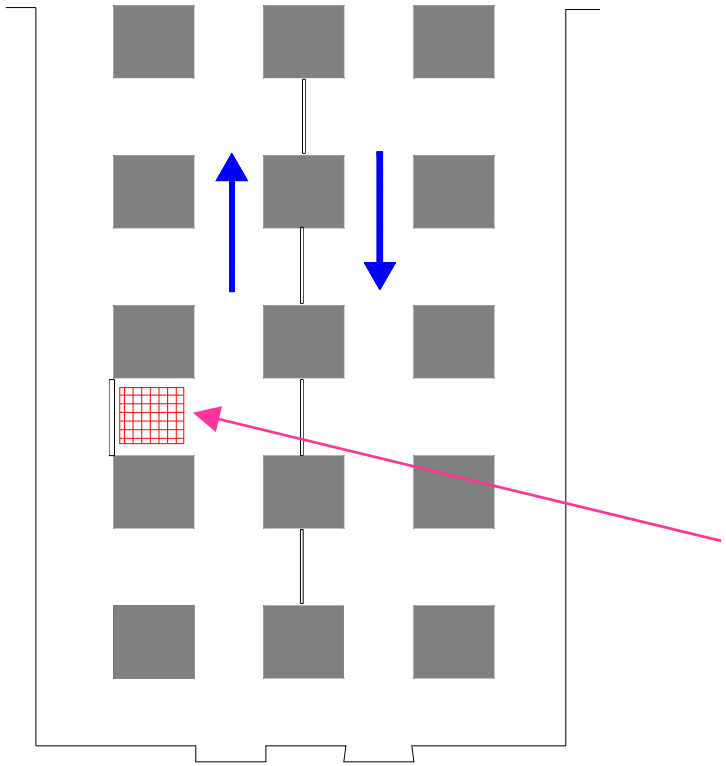
Standard storage temperature

Tips to Ensure Best Product

- Follow storage guidelines
- Limit stocks, eliminate sub-stores
- Place regular orders, matching usage



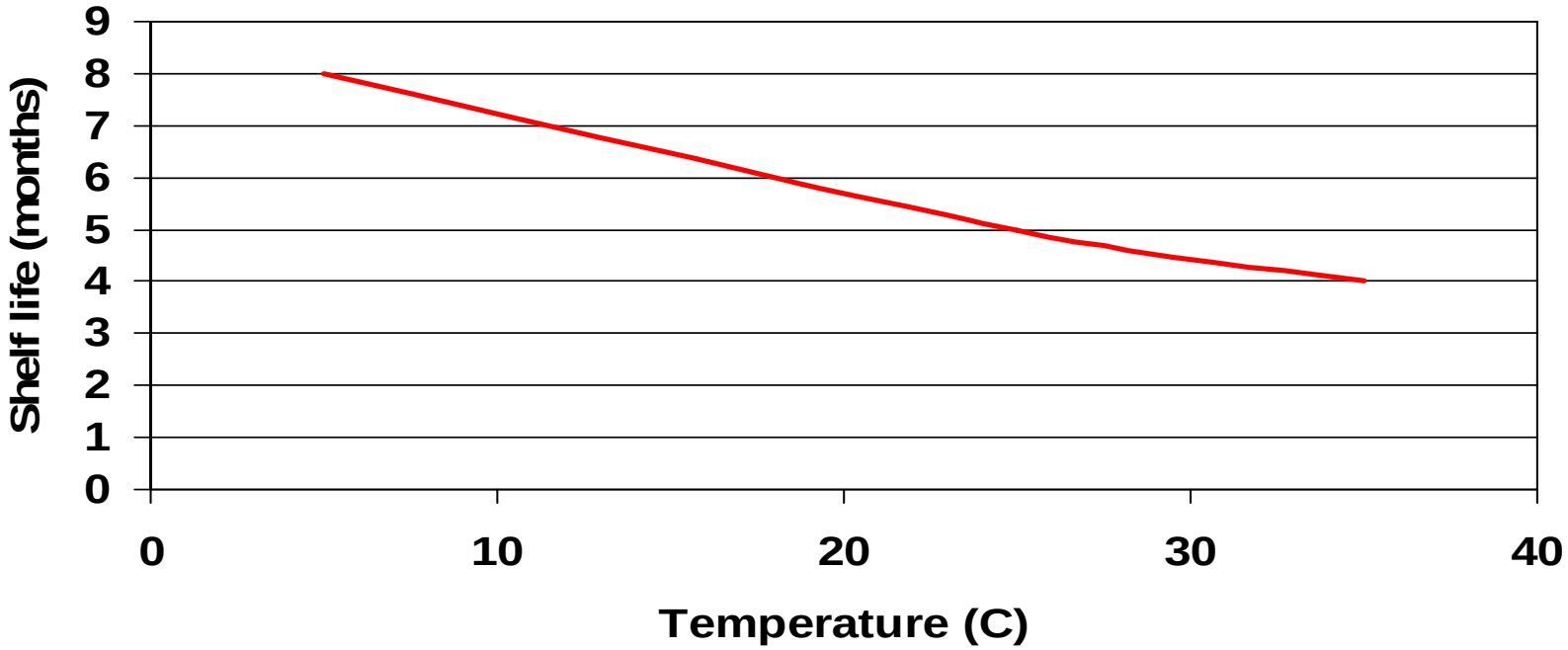
Underground Stores



Recommended if no suitable surface store and underground temperature < 20°C

STORE IN RETURN AIR ONLY !

Temperature and Shelf Life



Useful to Know ...

- Information on the box label
- Capsules per box
- Pallet dimensions, mass and box count
- Material Safety Data Sheets
- Contact Minova RSA

Lokset® Resin capsules comply with SABS 1534 and carry the SABS mark for quality

MINOVA

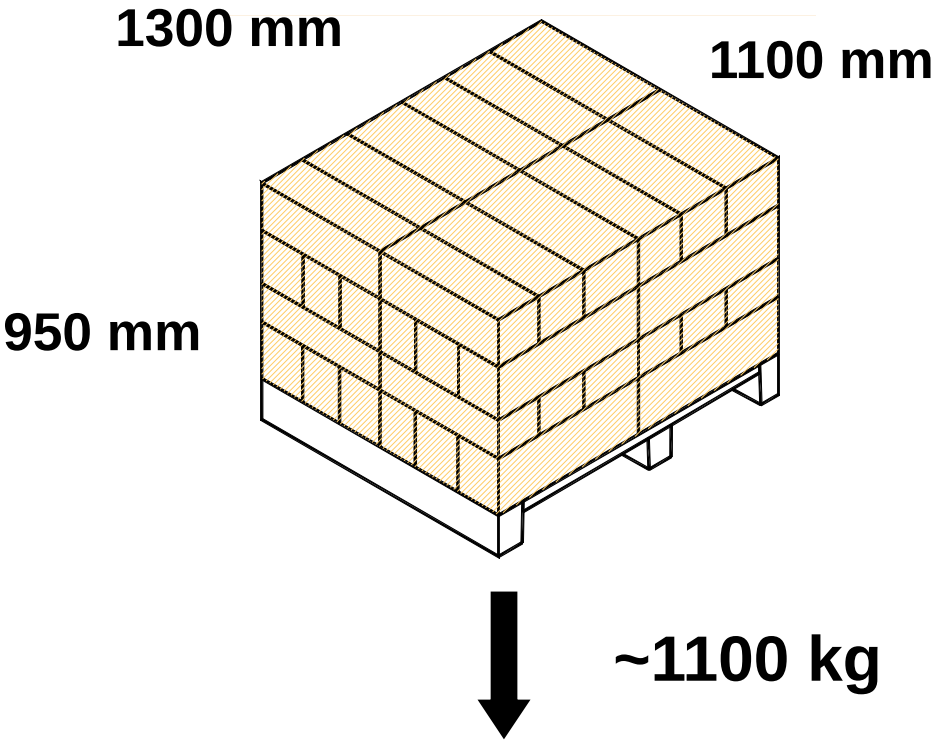
CLICK HERE TO RETURN TO MAIN MENU

Typical Capsules Per Box

Capsule Diameter	Length (mm)	
	380 – 500	>500
19	60	50
21	50	50
23	50	40
23	2-speedie: 20/box	
25	40	40
28		30
32	25	12
35	20	12

Box mass is approximately 16 kg

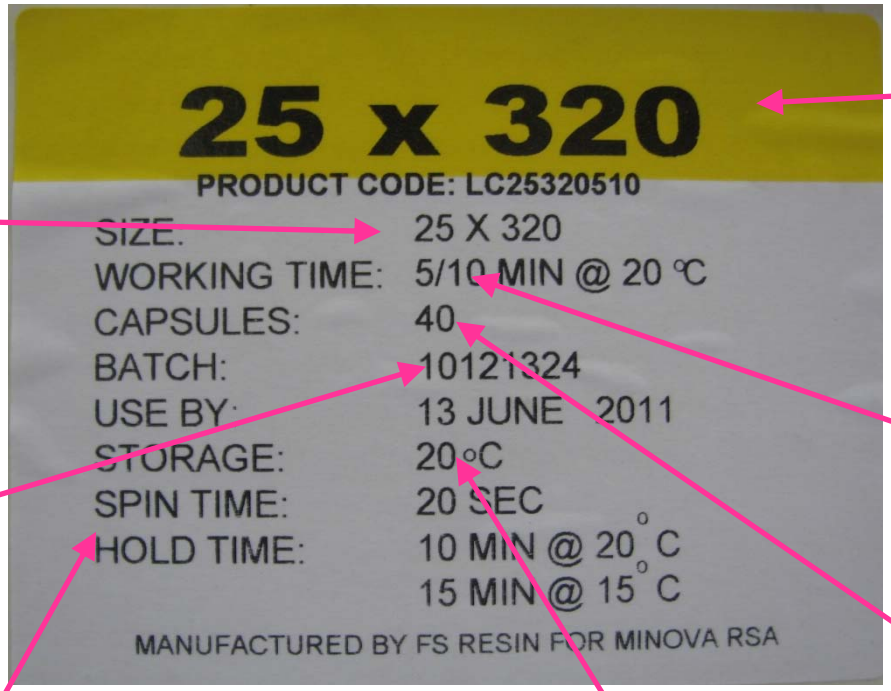
Pallet of Lokset® Resin



Usually:

60 boxes/pallet, except:
23x500 & 600 - 50/pallet
>600 mm long - 40/pallet

Information on Box Label



Diameter and length (mm)

Batch number

Instructions for use

Storage temperature

Capsule count

Working Time

Colour code for working time

Contact Minova RSA

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- e-mail rsamarketing@minovaint.com
- Post P.O. Box 52,
  Isando,
  1600,
  South Africa

MINOVA

Click Here to Return to Main menu

Troubleshooting Guide for Resin Bolting

MINOVA

What problem do you observe?
Click on the appropriate block

- Bolts protrude from roof, or bent bolts
- Excess thread below nut, or loose washers
- Bolts twisted off
- Low pull-out strength
- Shear pin not broken
- Resin does not fill hole

RETURN TO MAIN MENU

Bolts Protrude From Roof, or Bent Bolts

PROBLEM	POTENTIAL CAUSES	DIAGNOSTIC TESTS	SOLUTIONS
Bolts cannot be inserted	• Bolt diameter too large for hole	• Insert bar into hole with no resin	• Use larger drill bits or smaller bar
	• Bolt or hole not straight	• Visual inspection	• Handle carefully; consult supplier
	• Hole too short	• Measure hole, bar	• Mark drill steel
	• Resin too viscous or filler too coarse	• Check if resin past “use by” date	• Consult resin supplier
	• Two-speed system – fast resin installed last	• Observe operation	• Training
	• Resin too fast for installation method	• Check for high temperature; time installation	• Consult resin supplier; train operators
	• Roof bolter not directly below hole	• Check position of roofbolter	• Train operators
	• Spinning tool bent or wrong length	• Check spinning tool	• Replace spinning tool

Excess Thread Below Nut, or Loose Washers

PROBLEM	POTENTIAL CAUSES	DIAGNOSTIC TESTS	SOLUTIONS
Bolts not tensioned	• Shear pin too weak	• Check shear pin strength	• Consult bolt supplier
	• Thread stripped or bar thread undersized	• Examine bolt, nut threads	• Consult bolt supplier
	• Insufficient spinning	• Time operations; check spin RPM	• Operator training; maintenance
	• Hold time too short	• Check temperature; time operations	• Low temperature – increase hold time
	• Resin too slow	• Mix and time	• Consult resin supplier
	• Hole too short	• Measure hole length	• Mark drill steel
	• Roofbolter torque too low	• Check roofbolter torque	• Reset torque
	• See also “Bolts protrude from roof”	• See “Bolts protrude from roof”	• See “Bolts protrude from roof”

Low Pull-out Strength

PROBLEM	POTENTIAL CAUSES	DIAGNOSTIC TESTS	SOLUTIONS
Weak or insufficient resin bond	• Hole diameter too large	• Check bolt/bit/hole diameters	• Control bit sizes
	• Hole too long	• Measure hole depth	• Mark drill steel
	• Roof strata change	• Install another bolt with same materials in different location	• Consult resin supplier; increase bond length
	• Bent drill steel	• Check straightness	• Handle carefully; consult supplier
	• Insufficient resin in hole	• Measure resin column with wire	• Use more or longer capsules
	• Insufficient spinning	• Time operations; check spin RPM	• Operator training; maintenance
	• Over spinning	• Time spinning	• Operator training
	• Incompatible bar	• Short length pull tests	• Consult bolt and resin suppliers
	• Expired/faulty resin	• Check “use by” date; batch number	• Consult resin supplier

Bolts Twisted off

PROBLEM	POTENTIAL CAUSES	DIAGNOSTIC TESTS	SOLUTIONS
	• Roofbolter torque too high	• Measure with torque wrench – should be 230 – 250 Nm	• Reset torque bypass valve
	• Weak bolt or bolt under-diameter	• Measure diameter at narrowest part of bolt	• Consult bolt supplier

Shear pins or Breakouts Not Broken

PROBLEM	POTENTIAL CAUSES	DIAGNOSTIC TESTS	SOLUTIONS
Bolt will not be tensioned	• Hole too long	• Measure hole depth – should be 50 mm shorter than bolt	• Mark drill steel
	• Roofbolter torque too low	• Measure torque with wrench	• Reset torque bypass valve
	• Crimp or breakout too strong	• Measure with torque wrench	• Consult bolt supplier
	• See “Low pull-out strength”	• See “Low pull-out strength”	• See “Low pull-out strength”

Resin Does Not Fill Hole

PROBLEM	POTENTIAL CAUSES	DIAGNOSTIC TESTS	SOLUTIONS
Resin capsules volume not sufficient for hole volume	• Hole too long	• Measure hole depth	• Mark drill steel
	• Hole diameter too large	• Measure hole/bit diameter	• Control bits in use
	• Bar diameter undersized	• Measure bolt diameter	• Consult bolt supplier
	• Resin capsules too small	• Measure resin capsules – check against box label and order	• Consult resin supplier
	• Required resin volume underestimated	• Recheck calculations	• Allow 15% for resin loss into voids etc
	• Strata separation	• Boroscope	• Bolt immediately • Thrust bolter canopy against roof to close gaps