# A Look at Load-Distributing and Load-Sharing Anchor Systems

Presented by:

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# A Look at Load-Distributing and Load-Sharing Anchor Systems

Several variations of multi-point anchors are commonly used in rescue systems when bombproof anchors (oak trees, I-beams or fire trucks) are not available. There are several schools of thought and rigging considerations regarding proper rigging technique of both "load distributing" and "load sharing" multi-point anchor systems. In order to explore how the a load is distributed both statically and during a dynamic event, we have chosen various multi-point anchor ties using a maximum anchor length of 30 centimeters (12 inches) and using a maximum 90 degree outer angle.

## *About the Presenters*

**John McKently** has been with the Los Angeles County Sheriff's, Montrose Search and Rescue Team since 1974. The Team is a member of the Mountain Rescue Association (MRA) and responds to incidents ranging from car-overs and searches for overdue hikers, hunters and skiers to rescuing stranded or fallen climbers. Montrose' prime response area is approximately 500 square miles of the Angeles National Forest including Big Tujunga Canyon, most of the Angeles Crest and Angeles Forest Highways and includes two small ski areas. The team is also one of five Mine Rescue teams in California and has responded to underground emergencies throughout the state. He presently holds the rank of Reserve Commander with the Sheriff's Department and has experienced over 1700 callouts during his career with the Team. He has taught SAR Management for OES since 1988. He served on the Board of Directors of the National Association for Search and Rescue (NASAR) and was the Treasurer of that Association for four years. Active in the development of Search and Rescue standards since its inception in 1989, John served 6 years as the Chairman of ASTM Committee F-32 on Search and Rescue and authored several standards documents. After 20 years with a financial institution John is presently the School Director and Lead Instructor for CMC Rescue Inc. where he specializes in Rope Rescue, Confined Space Rescue and other specialized rescue training.

**Bruce Parker** is has been a Senior Lead Instructor for CMC Rescue School for 14 years. Bruce specializes in Rope Rescue, Confined Space and Rappel training. He is responsible for course development and compliance towards applicable standards such as NFPA 1670 & 1006. He is extremely concerned with rescuer and victim safety and has worked to develop and improve many products manufactured by CMC. Prior to joining the CMC Rescue team, he was the Training and Program Development Coordinator for Preparedness, Training, and Development. He researched, designed, taught, and coordinated several rescue programs for industries including: Emergency Response Teams; Rope Rescue and Confined Space Rescue; HAZWOPER; Medic First Aid Training; and EMT 1 Training and recertification. Bruce has taught Rope Rescue, Confined Space Rescue, Blood borne Pathogens, and Light Search and Rescue Training, to public agencies and private corporations. He has also designed and published safety manuals for several clients. He is active in ASTM as a member of the F32 Committee writing standards for Search and Rescue. He is rated to teach mine rescue by MSHA and is a State of California Senior Fire Instructor. Bruce has been a member of the Montrose Search and Rescue Team for 27 years, serving in all ranks including 3 years as Captain.

**Cedric Smith** has been an Engineering Technician at CMC Rescue since 2003. He works closely with the Product Development Committee and is responsible for product development, testing and certification. Prior to his employment with CMC he resided in Nova Scotia were he served as a volunteer firefighter with the Meteghan Fire Department as well as a member of Clare Municipal SAR. Cedric attended Seneca College in Toronto, Ontario, where he received a diploma in Fire Engineering Technology. While residing in Ontario he taught rescue courses for a recognized outdoor adventure company in the fields of Technical Rope, Swiftwater, and Ice Rescue. In addition to being an active ASTM F32 Committee member, Cedric is also a member of Santa Barbara County Search & Rescue and Santa Barbara County Air Support.

# Multi-point Anchors

When rigging a rescue anchor system, finding a "bombproof" anchor point that is perfectly situated is very rare. The need to build an anchor system that corrects for bad location or spreads the load over multiple weaker points is more the norm.

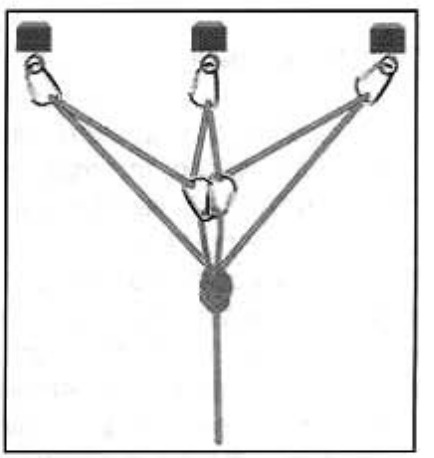
There are two major types of multi-point anchors; Load Sharing and Load Distributing.


Load Sharing Anchor

Load Sharing anchors have fixed length extensions from the various anchor points that connect together to support the load. Two factors determine how much load will end up on each anchor point. Those are the distance the anchor points are apart, which translates into the angle between the different legs, and the rigger's ability to tie the proper length extension for each point. Should one of the anchor points fail, their placement in relationship to the direction of pull will determine the resulting load on the remaining point(s). An ideal 3-point Load Sharing anchor would be similar to the one on the left. The three parallel legs would each support one third of the load. More often, the situation looks like the one on the right. The anchor points are far apart, which increases the force on each leg. If each extension isn't tied so the tension is equal to the other two, the increased force is not shared equally among the three anchor points.


Load Sharing Anchor

Load Distributing, sometimes called Self Equalizing, anchors have variable length extensions that, in a perfect world, would allow the load to be equally distributed to all the anchor points. The angle between the anchor points also affects Load Distributing anchor systems but the "adjusting" feature of the legs tends to solve the problem of tying the legs the proper length. Previous testing has shown that due to friction within the anchor system, true equalization does not occur, hence the shift away from calling them Self Equalizing. Additionally, due to the adjustability of the extensions, if one of the anchor points fails, slack is created within the anchor system that results in dynamic loading as the load is redistributed to the remaining anchor points.

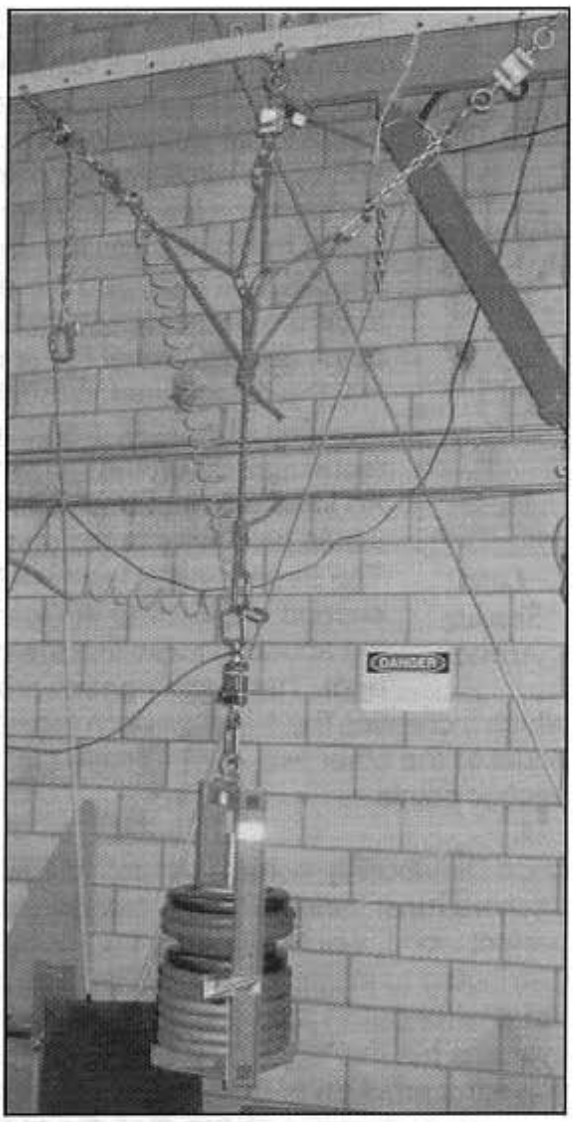


Load Distributing Anchor

Part One of these tests was designed to evaluate at how well the load is spread over 3-point anchor systems and whether the variability of the Load Distributing anchor does a better job than a Load Sharing anchor at spreading out the forces.

Part Two was designed to evaluate the results of an anchor point failure. We wanted to see how much dynamic loading and load shift is created within each anchor system when different anchor points are deliberately failed.

## The Test Set Up




Three anchor points were rigged on a drop tower with Load Cells to measure the force on each. Anchor Point #1 was on the left with an Omega 3000# load cell. Anchor Point #2 was in the middle with an Omega 5000# load cell and Anchor Point #3 was on the right with an Omega 5000# load cell. An Omega 10,000# load cell was between the anchor and the load to measure the maximum arrest force. A pneumatically controlled release was used to simulate a failure of the anchor points. The load was 2.65 kN (595 lbf).

Do to limited testing time, one variable that would reduce the maximum arrest force slightly was eliminated. Knots tighten when dynamically loaded which helps to resolve some of the dynamic energy thereby reducing the maximum arrest force. For consistency the test mass was dropped on each rope anchor system three times and each webbing anchor system once, to set the knots.

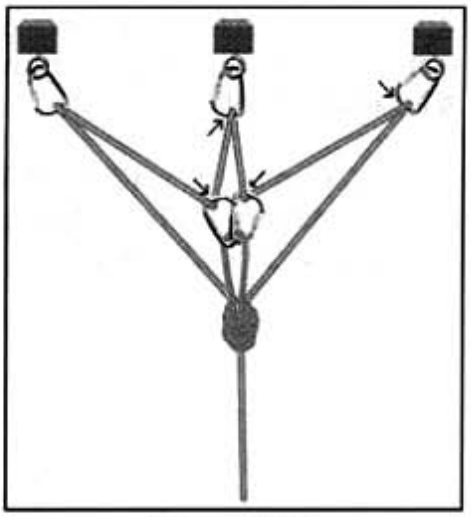
## Test Procedure

After each anchor system was rigged and visually equalized, the mass was lowered on to it. The "A" Test results indicate the force on each anchor point at that time. Then one of the anchor point was released, simulating a sudden failure, and the maximum force on the remaining anchor points and the load was recorded in the "B" Test. The extension of the anchor system was also recorded. Another parameter that should be considered is the sideways shift when an anchor point fails. Excessive sideways movement could cause the rope to move off edge protection resulting in rope damage or failure. When the #2 Anchor Point (the center one) was failed there was no shift as the forces transferred to the outside anchor points.

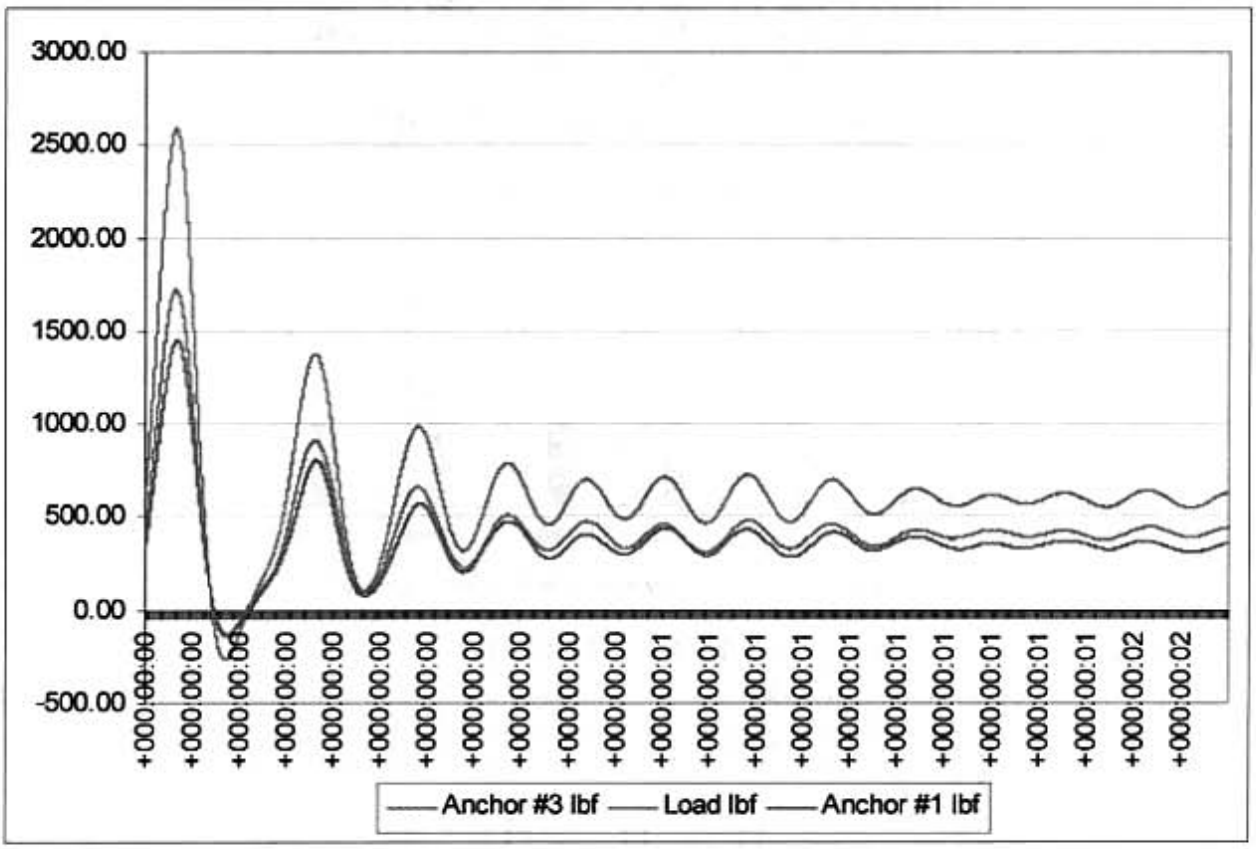
When one of the outside anchor points was failed, the load shifted to center between
the two remaining anchor points, in this case about 43 cm (17").

The leg lengths on the Load Distributing anchors were measured from where the rope bends around the carabiners.

Forces for the two remaining anchor points and the load was charted for each test. The pattern for each test was similar so only one example has been included.



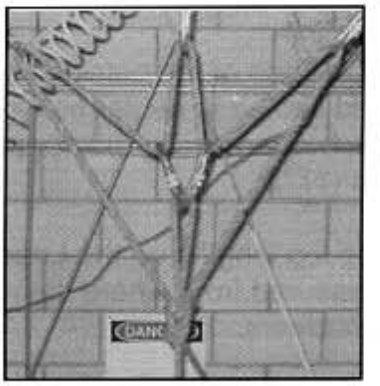
Leg Lengths

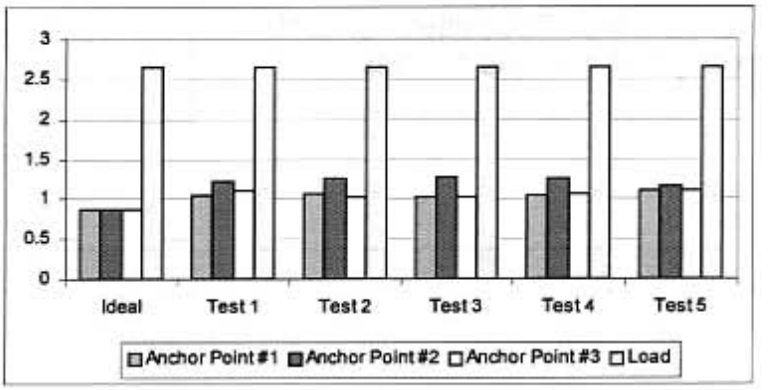



Anchor #3 = 1721 Load = 2592 Anchor #1 = 1454

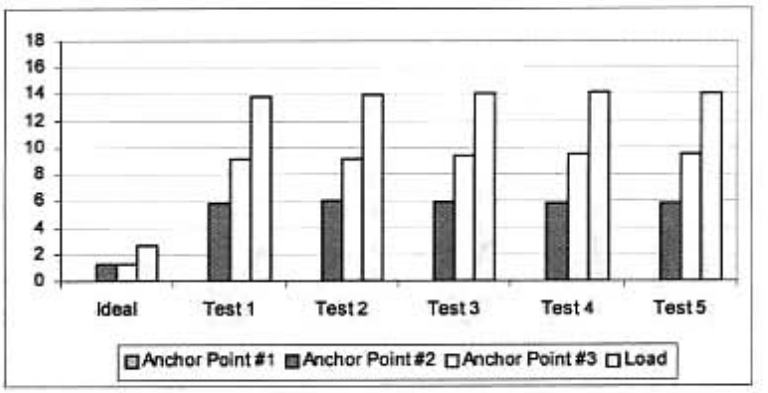
Anchor #1 - A Double Loop Figure Eight knot was tied with 12.5 mm Static Pro kernmantle rope and rigged into a Load Distributing anchor.

Legs - 29cm (11.5"), 16cm (6.5"), 29cm (11.5")
B-1 Extension - 27.1cm (10.7")
B-2 Extension - 12.8cm (5")

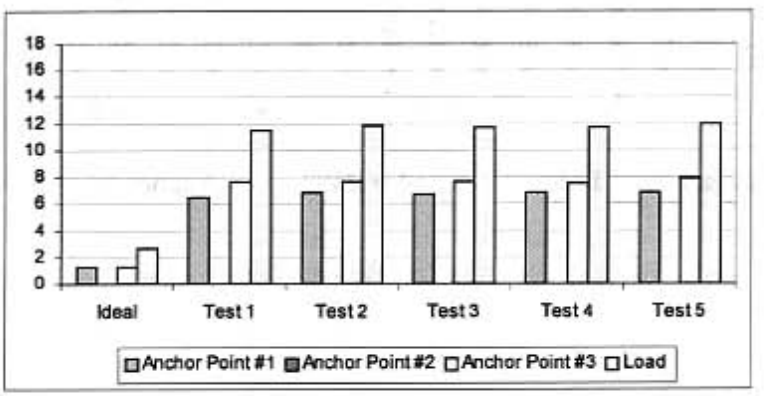





Anchor #1 - Test A

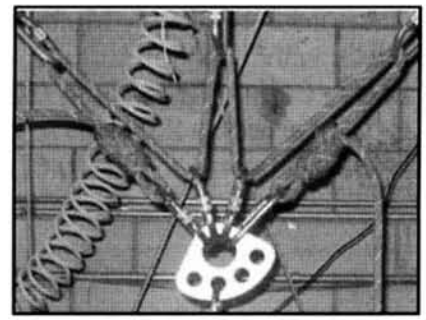


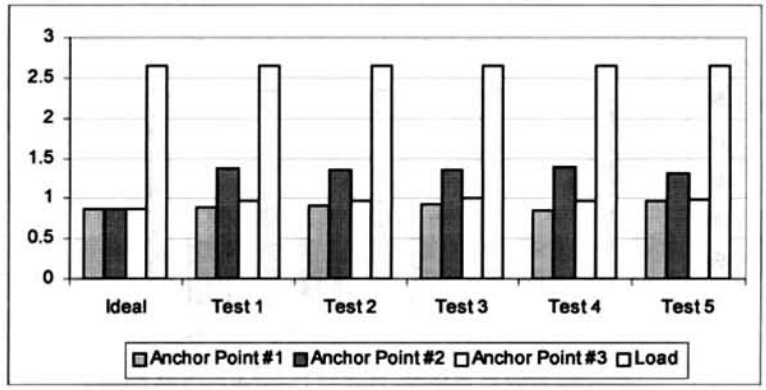

Anchor #1 - Test B-1



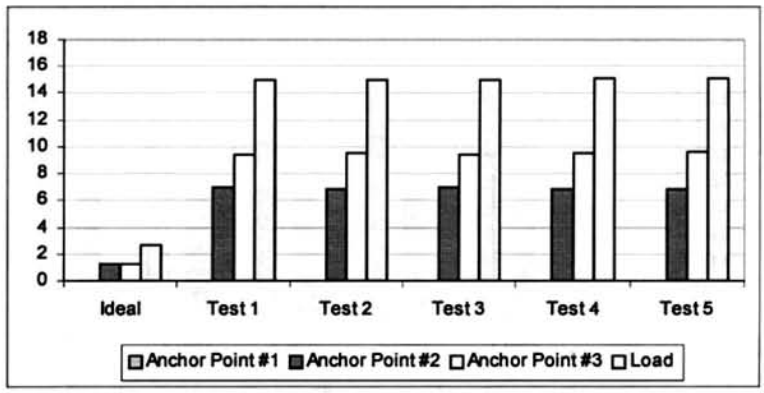

Anchor #1 - Test B-2

Anchor #2 - A Load Distributing anchor tied with 12.5mm Static Kernmantle rope using an anchor plate as a collection point.
Legs - 31cm (12.25"), 20cm (8"), 31cm (12.25")
B-1 Extension - 25.6cm (10")
B-2 Extension - 16.3cm (6.4")

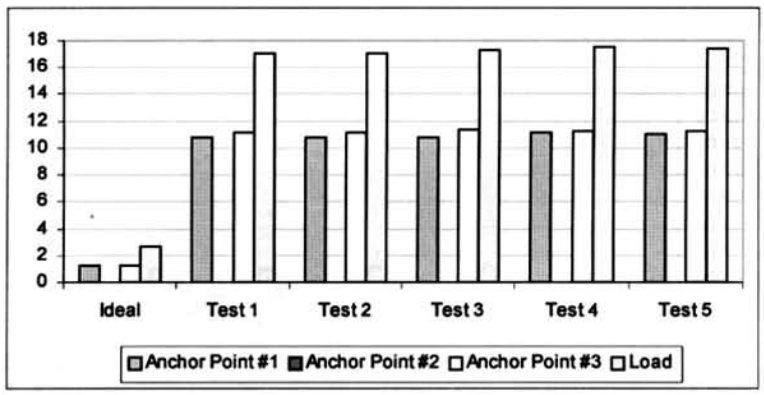





Anchor #2 - Test A

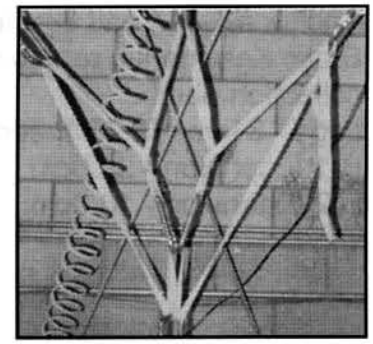


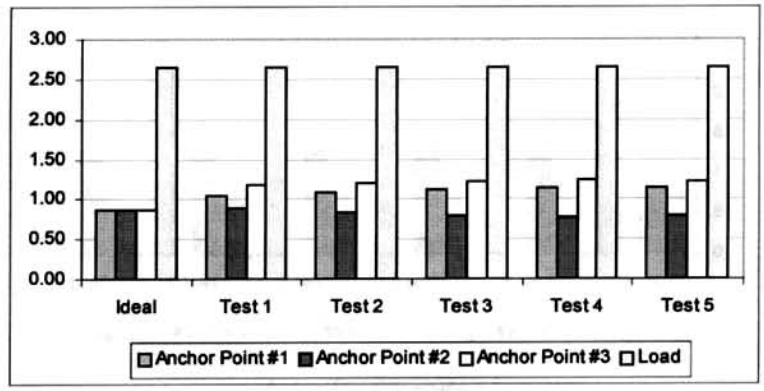

Anchor #2 - Test B-1



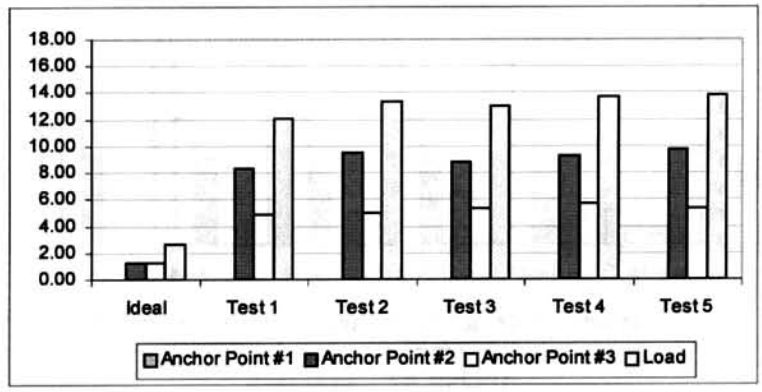

Anchor #2 - Test B-2

Anchor #3 - A 3-way Multi-point Load Distributing anchor made with 1" Nylon tubular webbing.
Legs - 30cm (12"), 30cm (12"), 30cm (12")
B-1 Extension - 23.1cm (9.1")
B-2 Extension - 1.5cm (0.6")

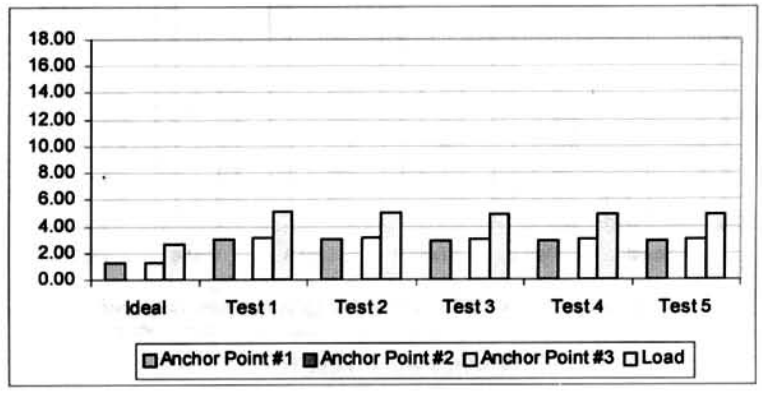





Anchor #3 - Test A

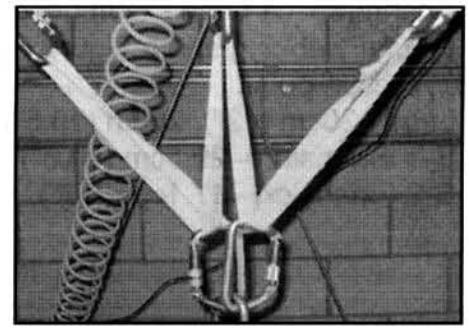


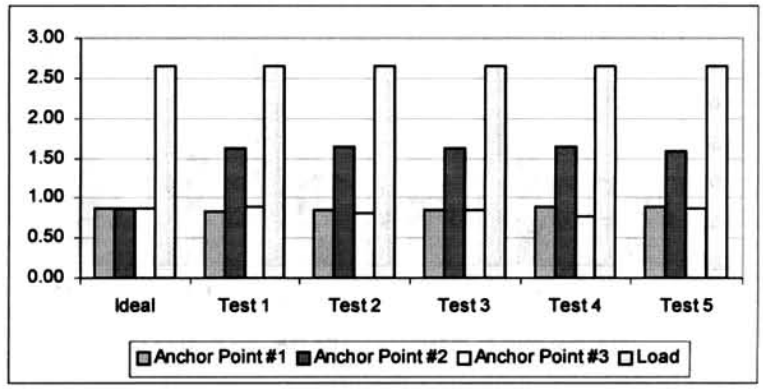

Anchor #3 - Test B-1



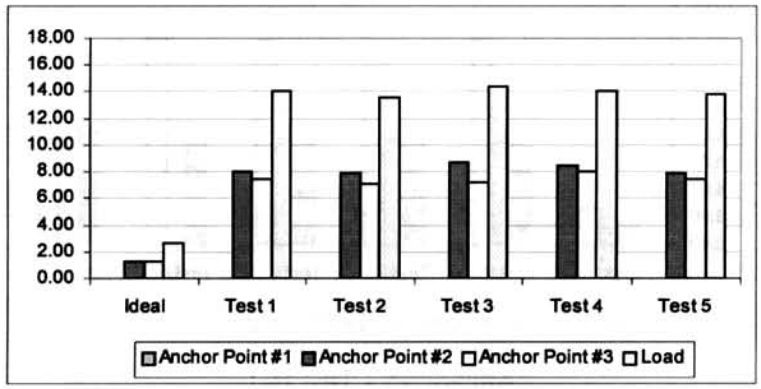

Anchor #3 - Test B-2

Anchor #4 - A Sliding X Load Distributing anchor made with 1" Nylon tubular webbing.
Legs - 30cm (12"), 21cm (8.5"), 30cm (12")
B-1 Extension - 27.6cm (10.9")
B-2 Extension - 15.5cm (6")

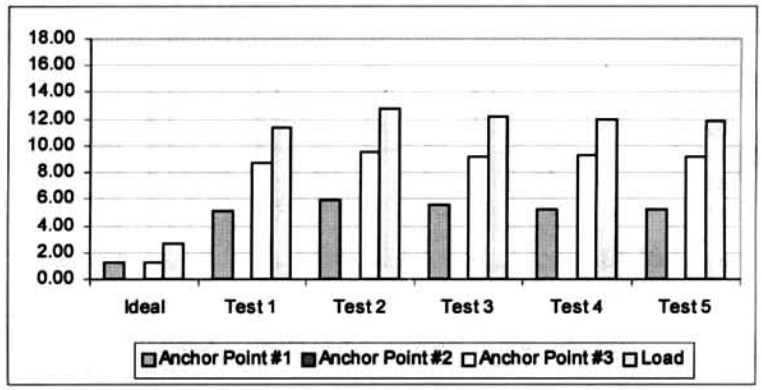





Anchor #4 - Test A

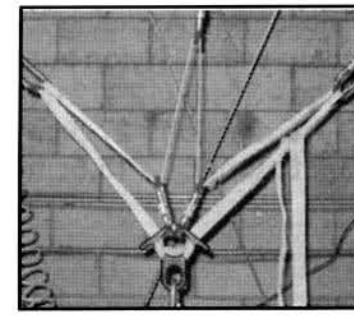


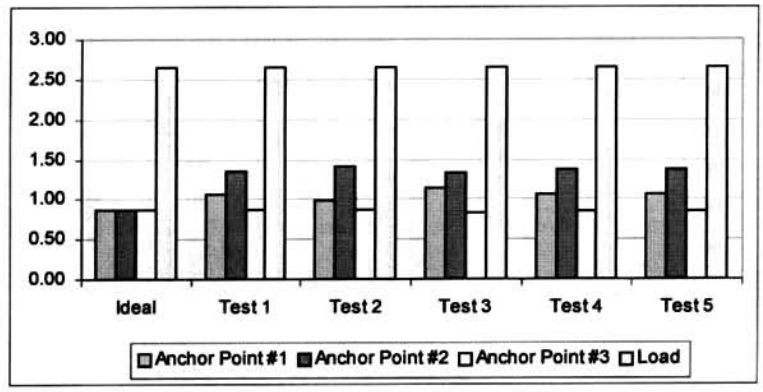

Anchor #4 - Test B-1



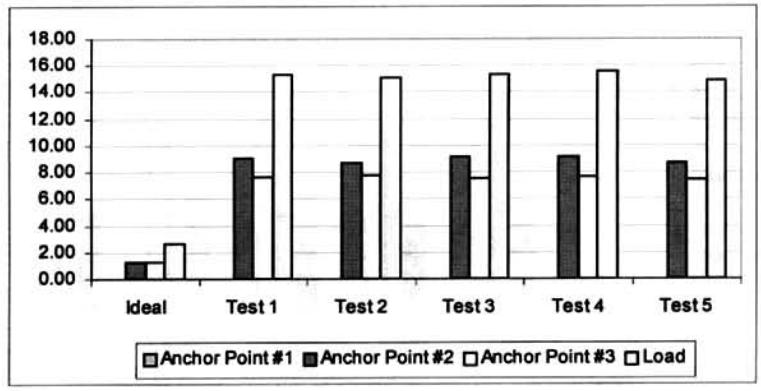

Anchor #4 - Test B-2

Anchor #5 - A Load Distributing anchor made with 1" Nylon tubular webbing and a Figure Eight descender as a sliding collection point.
Legs - 30cm (12"), 26cm (10.5"), 30cm (12")
B-1 Extension - 29.5cm (11.6")
B-2 Extension - 17.1cm (6.7")

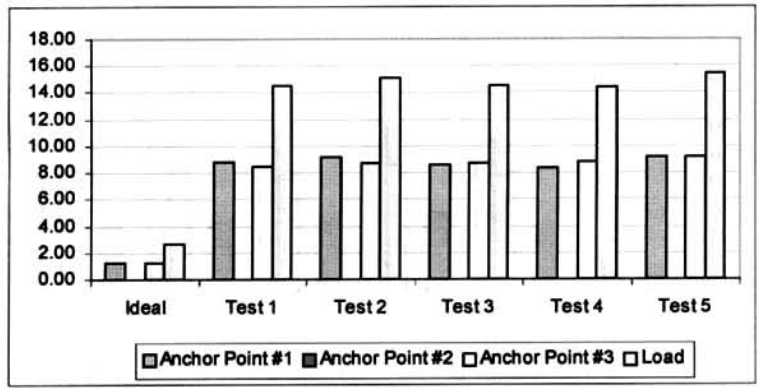





Anchor #5 - Test A

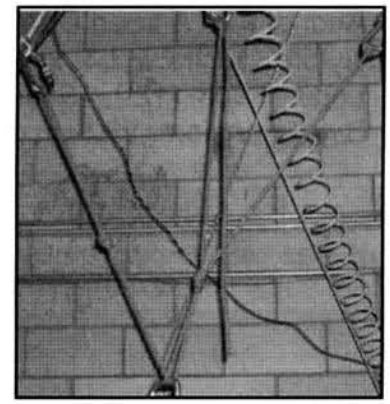


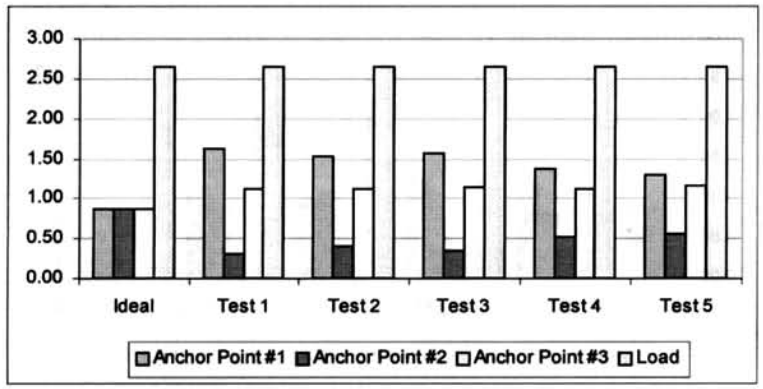

Anchor #5 - Test B-1



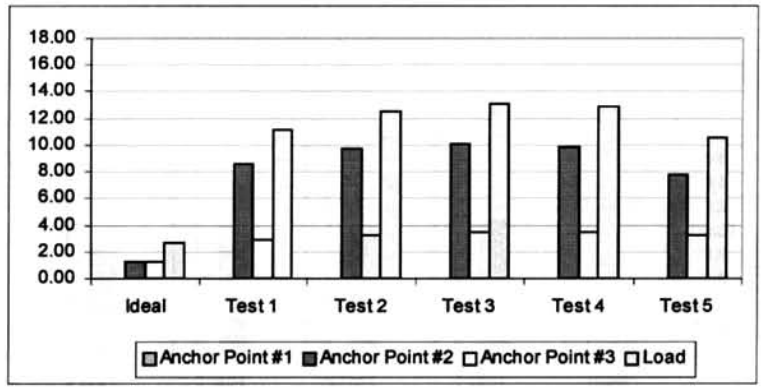

Anchor #5 - Test B-2

Anchor #6 - Equalette - A Load Distributing anchor made with 8 mm Nylon cord. This was found in the book Climbing Anchors. As rigged it is a two-point LDA with one leg attached to a single anchor point and the second leg attached to a two-pint load sharing anchor.
Legs - 30cm (12"), 20cm (8")
B-1 Extension - 59.4cm (23.4")
B-2 Extension - 2.4cm (1")

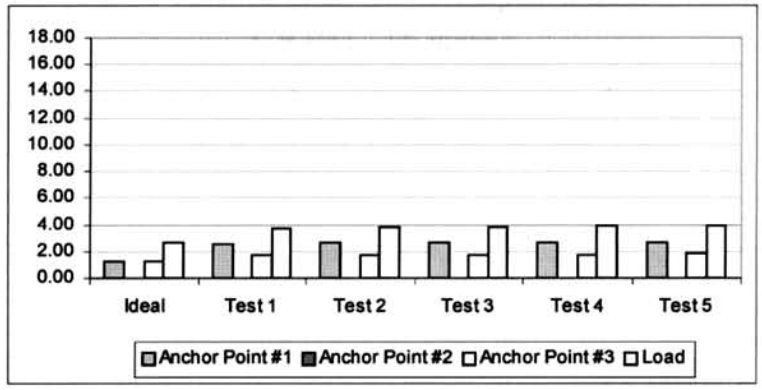





Anchor #6 - Test A

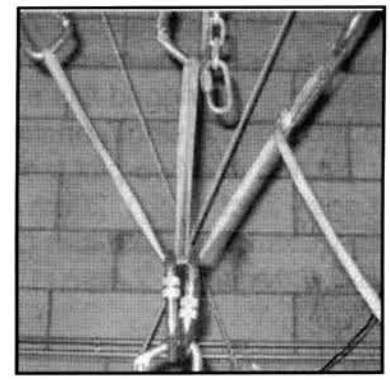


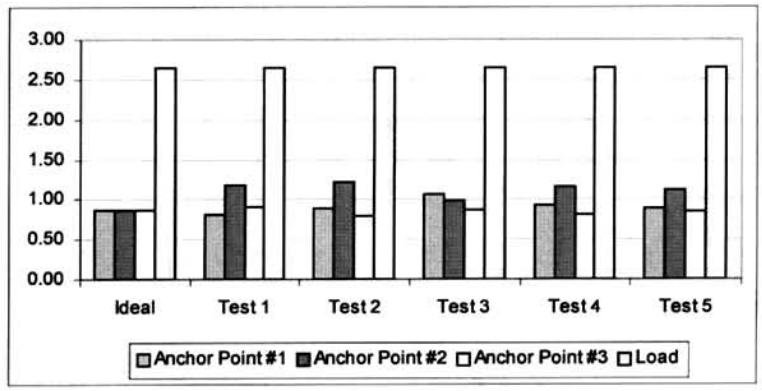

Anchor #6 - Test B-1



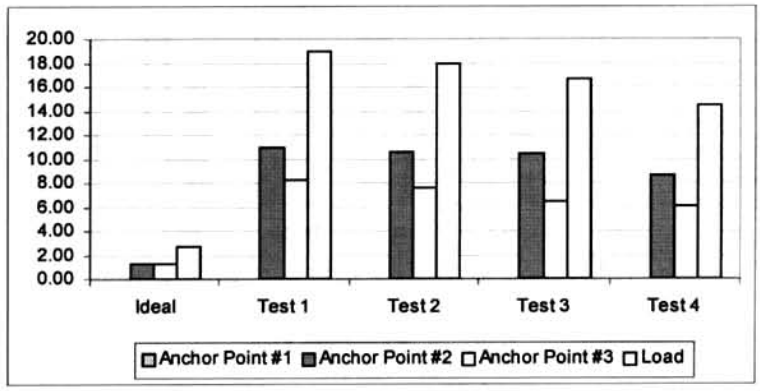

Anchor #6 - Test B-2

Anchor #7 - A Load Distributing anchor made with ½" Nylon/Spectra webbing.
Legs - 30cm (12"), 25cm (10"), 30cm (12")
B-1 Extension - 22.5cm (8.8")





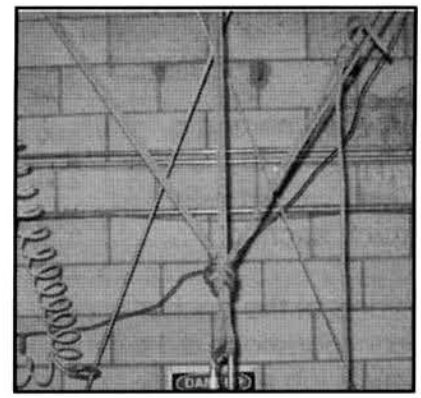

Anchor #7 - Test A

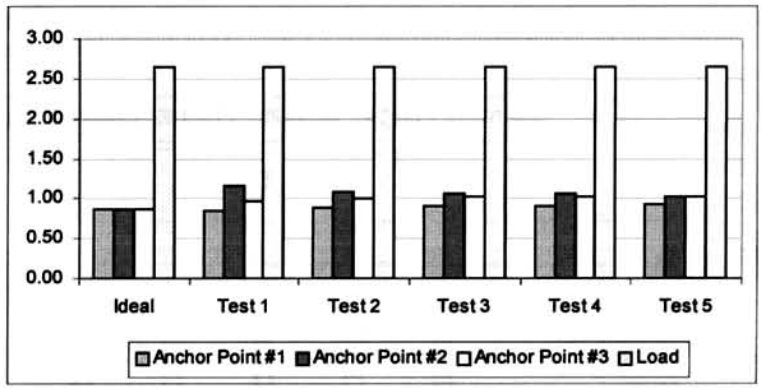



Anchor #7 - Test B-1

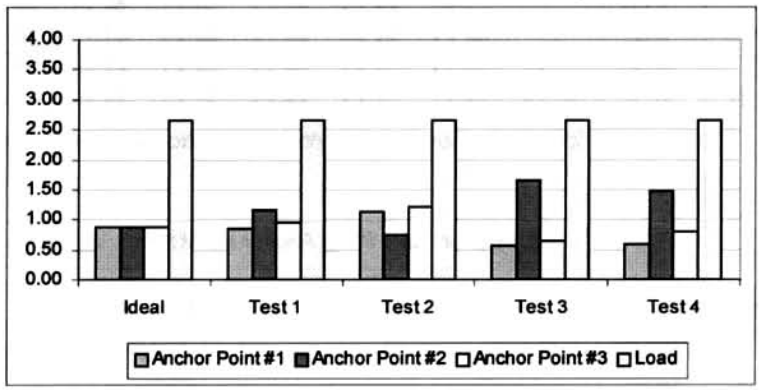
Anchor #8 - A Load Sharing anchor made with 8 mm cord.

B-1 Extension - 2.5cm (1")

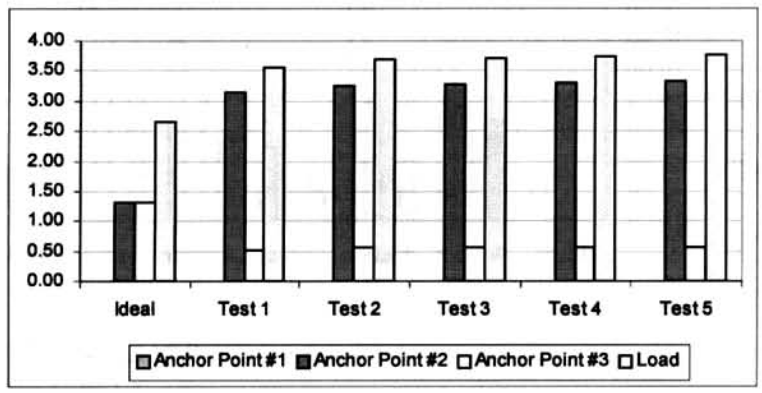





Anchor #8 - Test A




Anchor #8 - Test A-2

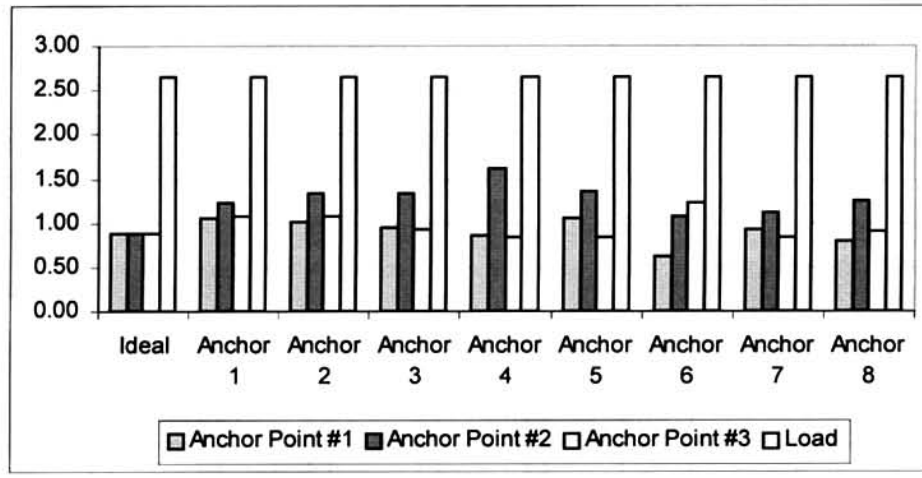



Anchor #8 - Test B-1

## Conclusions

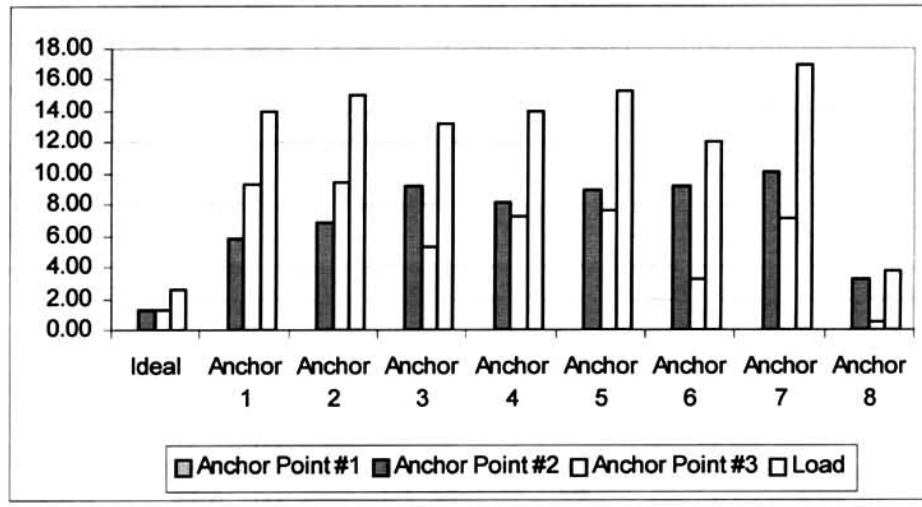
These charts are averages of the five tests we did with each anchor.

None of the anchor configurations did a great job at equally sharing the load.



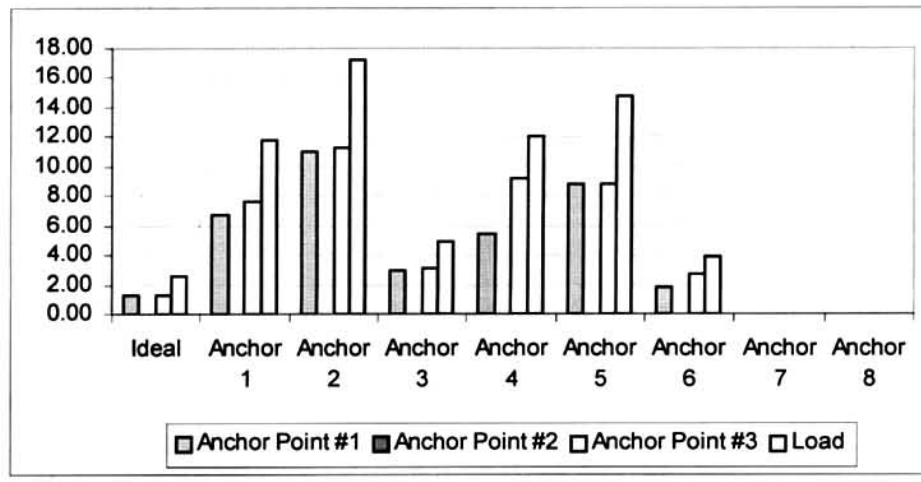

Test A

When anchor point #1 failed all the Load Distributing Anchors developed high Maximum Arrest Forces with poor equalization. The Load Sharing anchor had a much lower MAF but 87% of the load ended up on one anchor point.



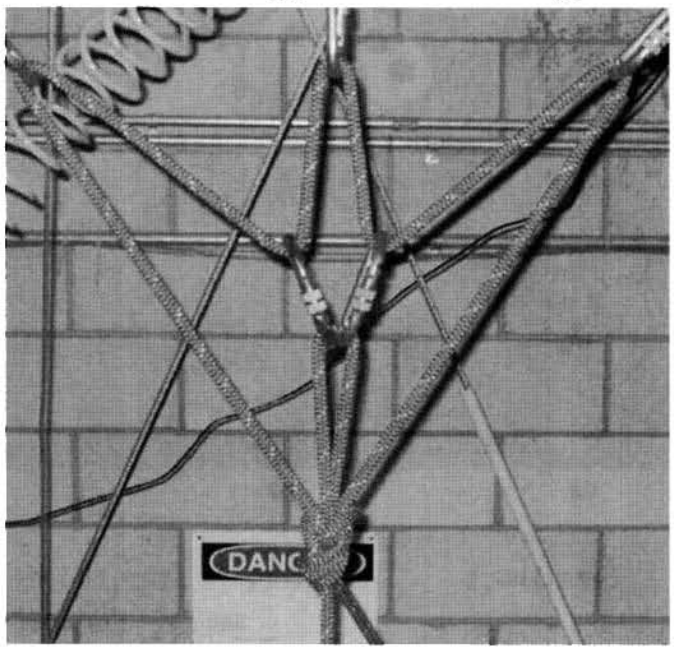

Test B-1

When anchor point #2 failed, some of the Load Distributing anchors performed better than others with relatively small MAF and good equalization.



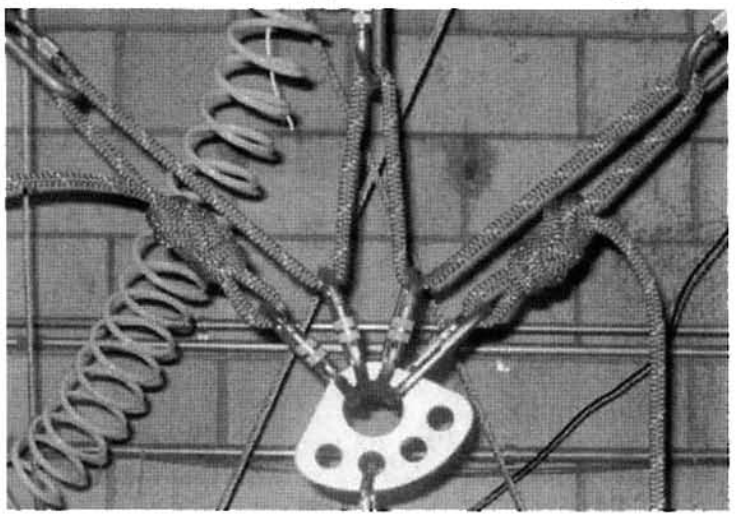

Test B-2

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in kN

| ANCHOR | Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|---|
| #1 - LDA - Double Loop Figure Eight | 1A | 1.05 | 1.22 | 1.11 | 2.65 | |
| CMC Static Pro - 12.5 mm | 1B | 0.00 | 5.75 | 9.23 | 13.77 | 26.34 |
| Legs - 29cm (11.5") 16cm (6.5") 29cm (11.5") | 2A | 1.07 | 1.26 | 1.03 | 2.65 | |
| #1 #2 #3 | 2B | 0.00 | 6.01 | 9.21 | 13.98 | 27.61 |
|  | 3A | 1.03 | 1.28 | 1.03 | 2.65 | |
| | 3B | 0.00 | 5.87 | 9.46 | 14.09 | 27.31 |
| | 4A | 1.05 | 1.25 | 1.06 | 2.65 | |
| | 4B | 0.00 | 5.84 | 9.49 | 14.11 | 27.31 |
| | 5A | 1.11 | 1.17 | 1.10 | 2.65 | |
| | 5B | 0.00 | 5.77 | 9.47 | 14.06 | 27.31 |
| | Mean A | 1.06 | 1.24 | 1.07 | 2.65 | |
| | Mean B-1 | 0.00 | 5.84 | 9.37 | 14.00 | 27.18 |
| | 6A | 0.90 | 1.13 | 1.09 | 2.65 | |
| | 6B | 6.47 | 0.00 | 7.65 | 11.53 | 13.00 |
| | 7A | 1.01 | 1.07 | 1.10 | 2.65 | |
| | 7B | 6.85 | 0.00 | 7.65 | 11.84 | 12.70 |
| | 8A | 0.94 | 1.13 | 1.07 | 2.65 | |
| | 8B | 6.74 | 0.00 | 7.67 | 11.77 | 12.70 |
| | 9A | 0.92 | 1.19 | 1.01 | 2.65 | |
| | 9B | 6.85 | 0.00 | 7.58 | 11.77 | 13.00 |
| | 10A | 1.09 | 0.85 | 1.27 | 2.65 | |
| | 10B | 6.80 | 0.00 | 7.86 | 11.98 | 12.70 |
| | Mean A | 0.97 | 1.07 | 1.11 | 2.65 | |
| | Mean B-2 | 6.74 | 0.00 | 7.68 | 11.78 | 12.83 |

#4

# CMC Rescue
# Multi-point Anchor Tests
# 2007
Force in kN

| ANCHOR | Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|---|
| #2 - LDA - Anchor Plate | 11A | 0.98 | 1.37 | 1.05 | 2.65 | |
| CMC Static Pro - 12.5 mm | 11B | 0.00 | 7.02 | 9.38 | 15.01 | 24.13 |
| Legs - 31cm (12.25") 20cm (8") 31cm (12.25") | 12A | 1.02 | 1.32 | 1.07 | 2.65 | |
| | 12B | 0.00 | 6.81 | 9.52 | 14.95 | 27.31 |
| #1 #2 #3 | 13A | 0.98 | 1.38 | 1.03 | 2.65 | |
|  | 13B | 0.00 | 6.93 | 9.41 | 14.98 | 24.57 |
| | 14A | 1.02 | 1.32 | 1.09 | 2.65 | |
| | 14B | 0.00 | 6.87 | 9.57 | 15.07 | 24.13 |
| | 15A | 1.05 | 1.28 | 1.12 | 2.65 | |
| | 15B | 0.00 | 6.81 | 9.66 | 15.07 | 27.94 |
| | Mean A | 1.01 | 1.33 | 1.07 | 2.65 | |
| | Mean B-1 | 0.00 | 6.89 | 9.51 | 15.02 | 25.63 |
| | 16A | 0.89 | 1.37 | 0.97 | 2.65 | |
| | 16B | 10.79 | 0.00 | 11.16 | 17.06 | 16.51 |
| | 17A | 0.91 | 1.36 | 0.96 | 2.65 | |
| | 17B | 10.85 | 0.00 | 11.12 | 17.10 | 15.88 |
| | 18A | 0.92 | 1.36 | 1.00 | 2.65 | |
| | 18B | 10.84 | 0.00 | 11.40 | 17.31 | 16.51 |
| | 19A | 0.86 | 1.40 | 0.96 | 2.65 | |
| | 19B | 11.16 | 0.00 | 11.26 | 17.48 | 16.51 |
| | 20A | 0.96 | 1.31 | 0.98 | 2.65 | |
| | 20B | 11.08 | 0.00 | 11.29 | 17.45 | 16.51 |
| | Mean A | 0.91 | 1.36 | 0.97 | 2.65 | |
| | Mean B-2 | 10.95 | 0.00 | 11.25 | 17.28 | 16.38 |

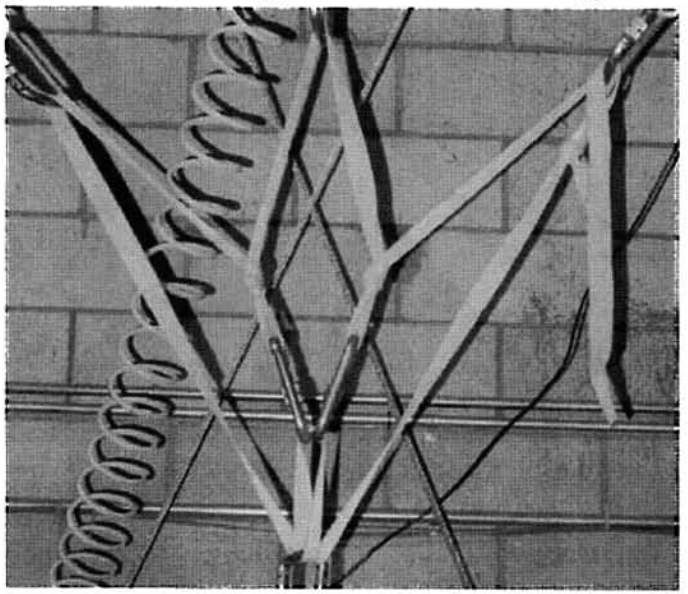
#4

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in kN

**ANCHOR**

#3 - LDA - 3-Way Multi-point Anchor
1" Tubular Nylon Webbing
Legs - 30cm (12") 30cm (12") 30cm (12")

#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|
| 21A | 1.01 | 1.26 | 0.97 | 2.65 | |
| 21B | 0.00 | 8.37 | 4.92 | 12.07 | 22.86 |
| 22A | 0.89 | 1.44 | 0.84 | 2.65 | |
| 22B | 0.00 | 9.53 | 5.00 | 13.34 | 22.86 |
| 23A | 0.98 | 1.27 | 0.99 | 2.65 | |
| 23B | 0.00 | 8.88 | 5.38 | 12.95 | 22.86 |
| 24A | 0.95 | 1.29 | 0.98 | 2.65 | |
| 24B | 0.00 | 9.29 | 5.64 | 13.66 | 23.50 |
| 25A | 0.88 | 1.41 | 0.88 | 2.65 | |
| 25B | 0.00 | 9.72 | 5.37 | 13.86 | 23.81 |
| Mean A | 0.94 | 1.33 | 0.93 | 2.65 | |
| Mean B-1 | 0.00 | 9.16 | 5.26 | 13.18 | 23.19 |
| 26A | 1.05 | 0.89 | 1.18 | 2.65 | |
| 26B | 2.99 | 0.00 | 3.15 | 5.08 | 1.91 |
| 27A | 1.09 | 0.84 | 1.20 | 2.65 | |
| 27B | 2.97 | 0.00 | 3.09 | 5.00 | 1.57 |
| 28A | 1.13 | 0.80 | 1.22 | 2.65 | |
| 28B | 2.93 | 0.00 | 3.03 | 4.91 | 2.54 |
| 29A | 1.15 | 0.77 | 1.23 | 2.65 | |
| 29B | 2.90 | 0.00 | 2.97 | 4.82 | 0.64 |
| 30A | 1.14 | 0.79 | 1.21 | 2.65 | |
| 30B | 2.94 | 0.00 | 3.05 | 4.92 | 1.27 |
| Mean A | 1.11 | 0.81 | 1.21 | 2.65 | |
| Mean B-2 | 2.95 | 0.00 | 3.06 | 4.94 | 1.57 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in kN

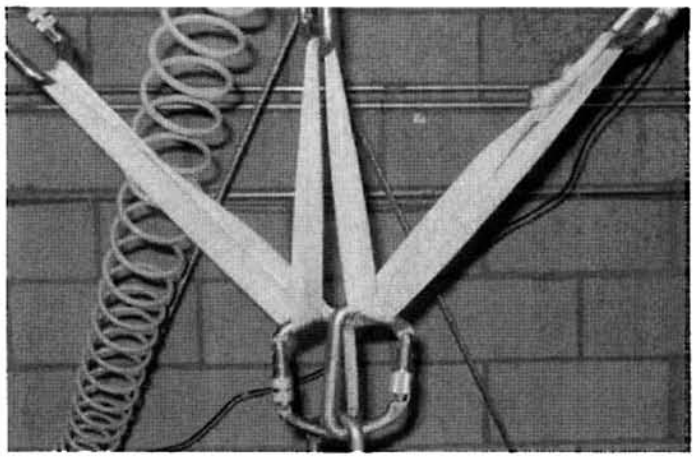
**ANCHOR**

#4 - LDA - Sliding X Anchor

1" Nylon Tubular Webbing

Legs - 30cm (12") 21cm (8.5") 30cm (12")

#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|
| 31A | 0.83 | 1.62 | 0.89 | 2.65 | |
| 31B | 0.00 | 8.07 | 7.44 | 14.07 | 27.94 |
| 32A | 0.86 | 1.65 | 0.81 | 2.65 | |
| 32B | 0.00 | 7.90 | 7.10 | 13.54 | 27.94 |
| 33A | 0.86 | 1.62 | 0.85 | 2.65 | |
| 33B | 0.00 | 8.67 | 7.17 | 14.38 | 27.31 |
| 34A | 0.89 | 1.65 | 0.78 | 2.65 | |
| 34B | 0.00 | 8.50 | 6.99 | 14.09 | 27.31 |
| 35A | 0.89 | 1.59 | 0.88 | 2.65 | |
| 35B | 0.00 | 7.88 | 7.42 | 13.86 | 27.94 |
| Mean A | 0.87 | 1.62 | 0.84 | 2.65 | |
| Mean B-1 | 0.00 | 8.21 | 7.22 | 13.99 | 27.69 |
| 36A | 0.73 | 1.42 | 0.95 | 2.65 | |
| 36B | 5.12 | 0.00 | 8.75 | 11.40 | 15.54 |
| 37A | 0.80 | 1.40 | 0.92 | 2.65 | |
| 37B | 5.95 | 0.00 | 9.50 | 12.73 | 15.88 |
| 38A | 0.81 | 1.40 | 0.91 | 2.65 | |
| 38B | 5.60 | 0.00 | 9.22 | 12.20 | 15.24 |
| 39A | 0.76 | 1.40 | 0.95 | 2.65 | |
| 39B | 5.28 | 0.00 | 9.24 | 11.98 | 15.24 |
| 40A | 0.78 | 1.35 | 1.00 | 2.65 | |
| 40B | 5.20 | 0.00 | 9.12 | 11.82 | 15.88 |
| Mean A | 0.77 | 1.39 | 0.94 | 2.65 | |
| Mean B-2 | 5.43 | 0.00 | 9.17 | 12.02 | 15.54 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in kN

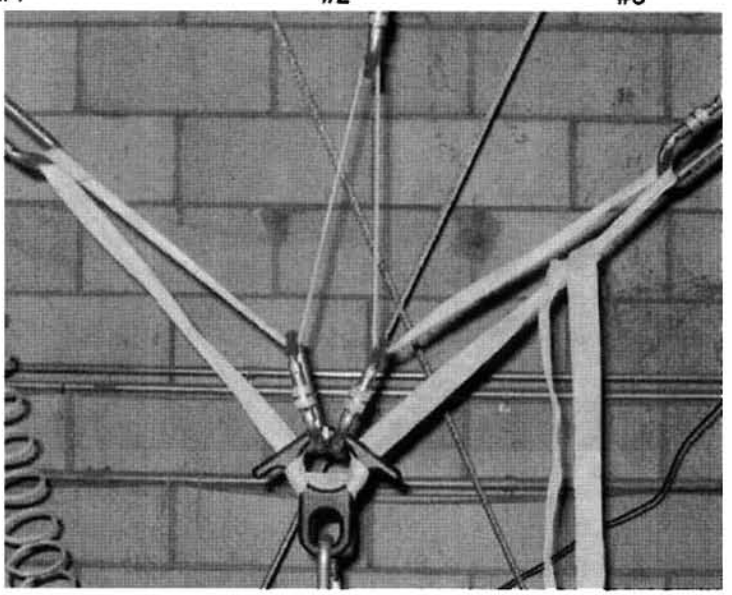
**ANCHOR**

#5 - LDA - Figure Eight Descender

1" Nylon Tubular Webbing

Legs - 30cm (12") 26cm (10.5") 30cm (12")

#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|
| 41A | 1.06 | 1.36 | 0.88 | 2.65 | |
| 41B | 0.00 | 9.02 | 7.66 | 15.35 | 29.21 |
| 42A | 0.98 | 1.42 | 0.87 | 2.65 | |
| 42B | 0.00 | 8.73 | 7.74 | 15.08 | 29.21 |
| 43A | 1.14 | 1.33 | 0.83 | 2.65 | |
| 43B | 0.00 | 9.12 | 7.54 | 15.33 | 29.85 |
| 44A | 1.06 | 1.38 | 0.85 | 2.65 | |
| 44B | 0.00 | 9.20 | 7.68 | 15.54 | 29.21 |
| 45A | 1.06 | 1.37 | 0.85 | 2.65 | |
| 45B | 0.00 | 8.72 | 7.48 | 14.89 | 30.48 |
| Mean A | 1.06 | 1.37 | 0.85 | 2.65 | |
| Mean B-1 | 0.00 | 8.96 | 7.62 | 15.24 | 29.59 |
| 46A | 0.87 | 1.25 | 0.97 | 2.65 | |
| 46B | 8.85 | 0.00 | 8.52 | 14.54 | 17.78 |
| 47A | 0.88 | 1.24 | 0.97 | 2.65 | |
| 47B | 9.22 | 0.00 | 8.76 | 15.10 | 18.42 |
| 48A | 0.90 | 1.26 | 0.92 | 2.65 | |
| 48B | 8.55 | 0.00 | 8.71 | 14.47 | 15.88 |
| 49A | 0.88 | 1.23 | 0.97 | 2.65 | |
| 49B | 8.31 | 0.00 | 8.88 | 14.43 | 15.88 |
| 50A | 0.89 | 1.22 | 0.99 | 2.65 | |
| 50B | 9.19 | 0.00 | 9.13 | 15.40 | 17.78 |
| Mean A | 0.89 | 1.24 | 0.97 | 2.65 | |
| Mean B-2 | 8.83 | 0.00 | 8.80 | 14.79 | 17.15 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in kN

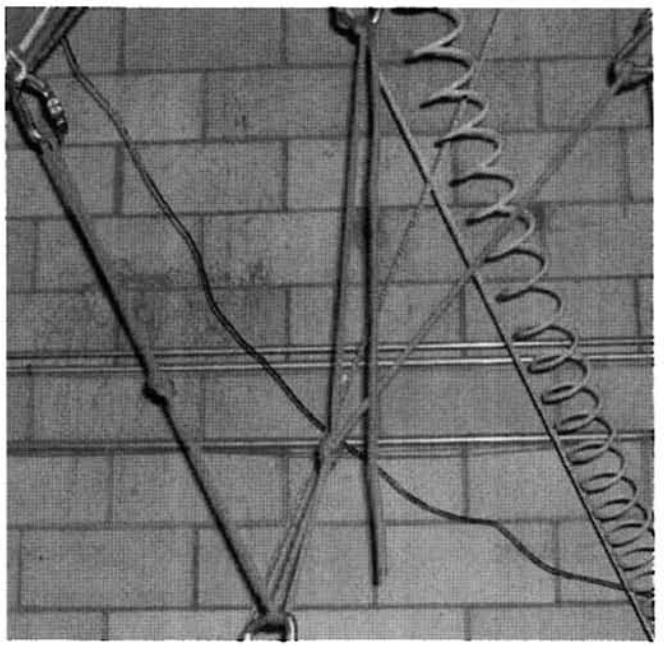
**ANCHOR**

#6 - LDA - Equalette (Climbing Anchors)

8 mm Nylon Cord

Legs - 30cm (12") 20cm (8")

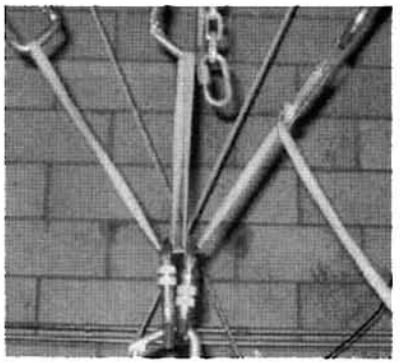
#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|
| 51A | 1.62 | 0.31 | 1.12 | 2.65 | |
| 51B | 0.00 | 8.64 | 2.93 | 11.17 | 57.15 |
| 52A | 1.53 | 0.40 | 1.12 | 2.65 | |
| 52B | 0.00 | 9.75 | 3.24 | 12.56 | 57.79 |
| 53A | 1.56 | 0.34 | 1.14 | 2.65 | |
| 53B | 0.00 | 10.11 | 3.49 | 13.17 | 59.69 |
| 54A | 1.37 | 0.53 | 1.12 | 2.65 | |
| 54B | 0.00 | 9.88 | 3.44 | 12.89 | 61.60 |
| 55A | 1.29 | 0.57 | 1.17 | 2.65 | |
| 55B | 0.00 | 7.80 | 3.20 | 10.52 | 60.96 |
| Mean A | 1.48 | 0.43 | 1.11 | 2.65 | |
| Mean B-1 | 0.00 | 9.24 | 3.26 | 12.06 | 59.44 |
| 56A | 1.24 | 1.04 | 0.66 | 2.65 | |
| 56B | 2.56 | 0.00 | 1.69 | 3.70 | 3.18 |
| 57A | 1.23 | 1.07 | 0.63 | 2.65 | |
| 57B | 2.64 | 0.00 | 1.74 | 3.81 | 2.54 |
| 58A | 1.22 | 1.08 | 0.63 | 2.65 | |
| 58B | 2.67 | 0.00 | 1.76 | 3.86 | 1.91 |
| 59A | 1.23 | 1.07 | 0.62 | 2.65 | |
| 59B | 2.71 | 0.00 | 1.78 | 3.91 | 2.54 |
| 60A | 1.19 | 1.11 | 0.61 | 2.65 | |
| 60B | 2.70 | 0.00 | 1.81 | 3.93 | 2.54 |
| Mean A | 1.22 | 1.07 | 0.63 | 2.65 | |
| Mean B-2 | 2.66 | 0.00 | 1.76 | 3.84 | 2.54 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in kN

| ANCHOR | Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|---|
| #7 - LDA - 3-point Webbing Anchor | 61A | 0.81 | 1.18 | 0.91 | 2.65 | |
| .5" Nylon/Spectra Webbing | 61B | 0.00 | 10.99 | 8.28 | 18.98 | 22.23 |
| Legs - 30cm (12") 25cm (10") 30cm (12") | 62A | 0.89 | 1.21 | 0.80 | 2.65 | |
|  | 62B | 0.00 | 10.56 | 7.64 | 17.92 | 22.86 |
| | 63A | 1.07 | 0.98 | 0.88 | 2.65 | |
| | 63B | 0.00 | 10.39 | 6.50 | 16.66 | 21.59 |
| | 64A | 0.93 | 1.17 | 0.81 | 2.65 | |
| | 64B | 0.00 | 8.66 | 6.04 | 14.50 | 23.50 |
| | 65A | 0.90 | 1.13 | 0.86 | 2.65 | |
| | 65B | | | | | Fail |
| | Mean A | 0.92 | 1.13 | 0.85 | 2.65 | |
| | Mean B-1 | 0.00 | 10.15 | 7.12 | 17.01 | 22.56 |

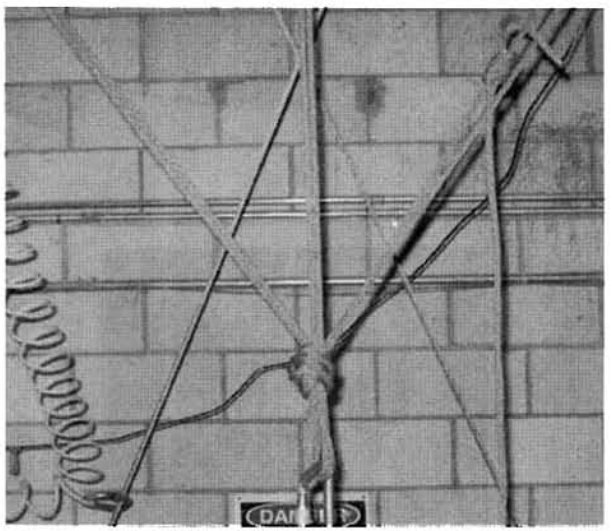
**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in kN

**ANCHOR**

#8 - LSA - Cordelette

8 mm Nylon Cord

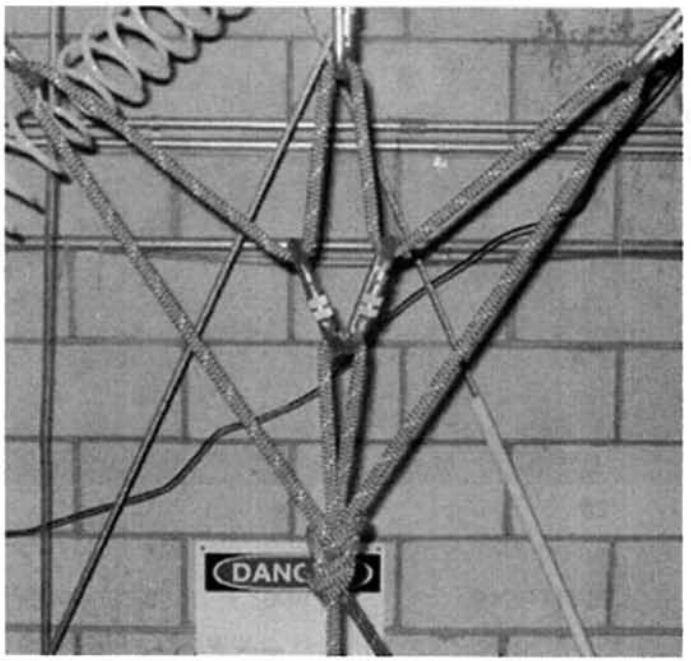
#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension cm |
|---|---|---|---|---|---|
| 66A | 0.85 | 1.17 | 0.96 | 2.65 | |
| 66B | 0.00 | 3.14 | 0.52 | 3.56 | 1.91 |
| 67A | 0.90 | 1.08 | 1.01 | 2.65 | |
| 67B | 0.00 | 3.24 | 0.56 | 3.68 | 2.54 |
| 68A | 0.91 | 1.06 | 1.02 | 2.65 | |
| 68B | 0.00 | 3.28 | 0.56 | 3.72 | 3.18 |
| 69A | 0.91 | 1.06 | 1.02 | 2.65 | |
| 69B | 0.00 | 3.30 | 0.56 | 3.75 | 2.54 |
| 70A | 0.93 | 1.03 | 1.03 | 2.65 | |
| 70B | 0.00 | 3.32 | 0.58 | 3.78 | 2.54 |
| Mean A | 0.90 | 1.08 | 1.01 | 2.65 | |
| Mean B-1 | 0.00 | 3.26 | 0.56 | 3.70 | 2.54 |
| 71A | 1.14 | 0.75 | 1.21 | 2.65 | |
| 71B | | | | | |
| 72A | 0.56 | 1.65 | 0.65 | 2.65 | |
| 72B | | | | | |
| 73A | 0.60 | 1.48 | 0.81 | 2.65 | |
| 73B | | | | | |
| 74A | 0.85 | 1.17 | 0.96 | 2.65 | |
| 74B | | | | | |
| 75A | | | | | |
| 75B | | | | | |
| Mean A | 0.79 | 1.26 | 0.91 | 2.65 | |
| | | | | | |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in lbf

| ANCHOR | Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|---|
| #1 - LDA - Double Loop Figure Eight | 1A | 235 | 275 | 250 | 595 | |
| CMC Static Pro - 12.5 mm | 1B | 0 | 1292 | 2075 | 3096 | 10.37 |
| Legs - 29cm (11.5") 16cm (6.5") 29cm (11.5") | 2A | 240 | 283 | 231 | 595 | |
| #1 #2 #3 | 2B | 0 | 1350 | 2070 | 3143 | 10.87 |
|  | 3A | 232 | 288 | 232 | 595 | |
| | 3B | 0 | 1319 | 2126 | 3168 | 10.75 |
| | 4A | 236 | 280 | 239 | 595 | |
| | 4B | 0 | 1314 | 2134 | 3173 | 10.75 |
| | 5A | 250 | 264 | 247 | 595 | |
| | 5B | 0 | 1297 | 2130 | 3160 | 10.75 |
| | Mean A | 239 | 278 | 240 | 595 | |
| | Mean B-1 | 0 | 1314 | 2107 | 3148 | 10.70 |
| | 6A | 202 | 253 | 245 | 595 | |
| | 6B | 1454 | 0 | 1720 | 2592 | 5.12 |
| | 7A | 227 | 240 | 248 | 595 | |
| | 7B | 1539 | 0 | 1720 | 2661 | 5.00 |
| | 8A | 211 | 253 | 240 | 595 | |
| | 8B | 1515 | 0 | 1725 | 2645 | 5.00 |
| | 9A | 206 | 267 | 227 | 595 | |
| | 9B | 1539 | 0 | 1703 | 2646 | 5.12 |
| | 10A | 244 | 192 | 285 | 595 | |
| | 10B | 1529 | 0 | 1768 | 2694 | 5.00 |
| | Mean A | 218 | 241 | 249 | 595 | |
| | Mean B-2 | 1515 | 0 | 1727 | 2648 | 5.05 |

#4

# CMC Rescue
# Multi-point Anchor Tests
# 2007
Force in lbf

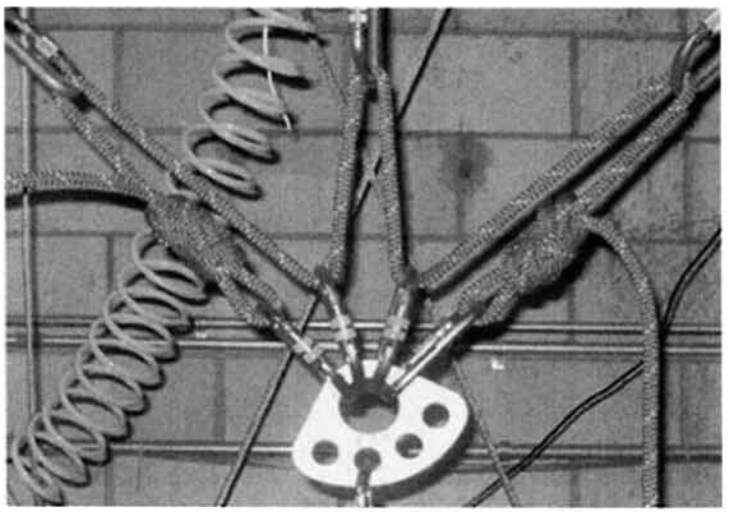
**ANCHOR**

#2 - LDA - Anchor Plate

CMC Static Pro - 12.5 mm

Legs - 31cm (12.25") 20cm (8") 31cm (12.25")

#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|
| 11A | 220 | 307 | 237 | 595 | |
| 11B | 0 | 1579 | 2109 | 3374 | 9.50 |
| 12A | 230 | 297 | 241 | 595 | |
| 12B | 0 | 1531 | 2140 | 3360 | 10.75 |
| 13A | 221 | 310 | 232 | 595 | |
| 13B | 0 | 1559 | 2116 | 3368 | 9.68 |
| 14A | 229 | 297 | 245 | 595 | |
| 14B | 0 | 1545 | 2151 | 3388 | 9.50 |
| 15A | 235 | 287 | 251 | 595 | |
| 15B | 0 | 1532 | 2172 | 3389 | 11.00 |
| Mean A | 227 | 300 | 241 | 595 | |
| Mean B-1 | 0 | 1549 | 2138 | 3376 | 10.09 |
| 16A | 199 | 307 | 219 | 595 | |
| 16B | 2425 | 0 | 2509 | 3836 | 6.50 |
| 17A | 205 | 306 | 215 | 595 | |
| 17B | 2440 | 0 | 2501 | 3844 | 6.25 |
| 18A | 206 | 306 | 224 | 595 | |
| 18B | 2438 | 0 | 2563 | 3891 | 6.50 |
| 19A | 193 | 315 | 215 | 595 | |
| 19B | 2510 | 0 | 2532 | 3930 | 6.50 |
| 20A | 215 | 294 | 220 | 595 | |
| 20B | 2490 | 0 | 2539 | 3922 | 6.50 |
| Mean A | 204 | 306 | 219 | 595 | |
| Mean B-2 | 2461 | 0 | 2529 | 3885 | 6.45 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in lbf

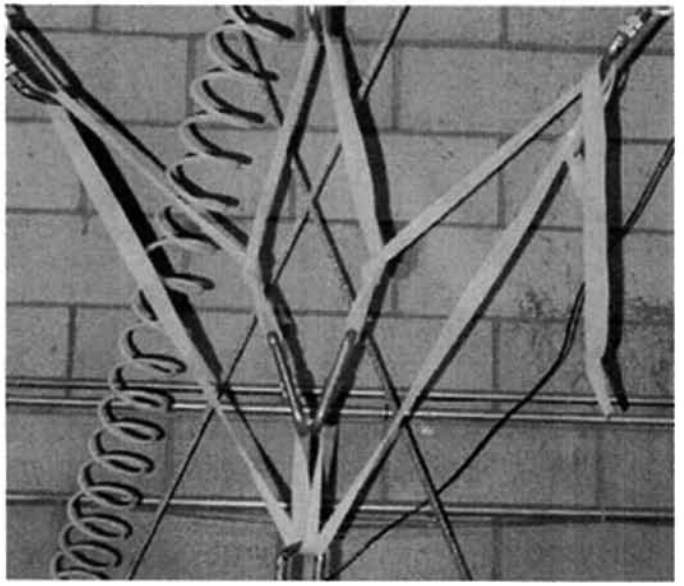
**ANCHOR**

#3 - LDA - 3-Way Multi-point Anchor

1" Tubular Nylon Webbing

Legs - 30cm (12") 30cm (12") 30cm (12")

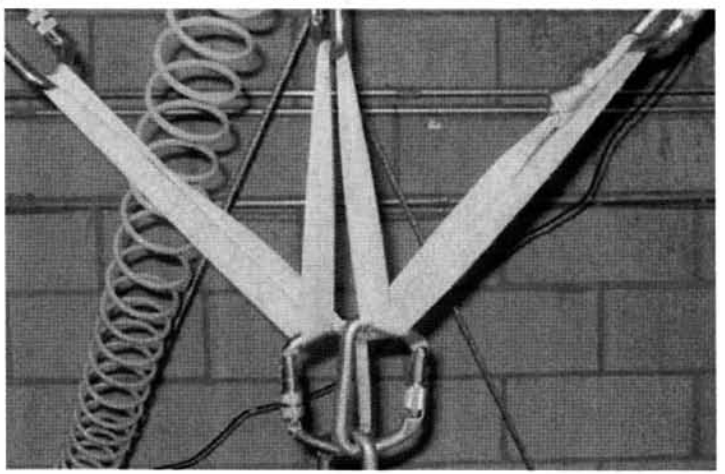
#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|
| 21A | 228 | 284 | 219 | 595 | |
| 21B | 0 | 1881 | 1105 | 2714 | 9.00 |
| 22A | 201 | 324 | 188 | 595 | |
| 22B | 0 | 2142 | 1123 | 3000 | 9.00 |
| 23A | 221 | 285 | 222 | 595 | |
| 23B | 0 | 1997 | 1209 | 2912 | 9.00 |
| 24A | 213 | 291 | 220 | 595 | |
| 24B | 0 | 2089 | 1268 | 3070 | 9.25 |
| 25A | 198 | 316 | 198 | 595 | |
| 25B | 0 | 2185 | 1208 | 3116 | 9.38 |
| Mean A | 212 | 300 | 209 | 595 | |
| Mean B-1 | 0 | 2059 | 1183 | 2962 | 9.13 |
| 26A | 237 | 199 | 266 | 595 | |
| 26B | 673 | 0 | 708 | 1141 | 0.75 |
| 27A | 246 | 188 | 270 | 595 | |
| 27B | 668 | 0 | 694 | 1123 | 0.62 |
| 28A | 253 | 179 | 274 | 595 | |
| 28B | 659 | 0 | 681 | 1104 | 1.00 |
| 29A | 258 | 173 | 277 | 595 | |
| 29B | 652 | 0 | 668 | 1083 | 0.25 |
| 30A | 257 | 178 | 273 | 595 | |
| 30B | 662 | 0 | 685 | 1106 | 0.50 |
| Mean A | 250 | 183 | 272 | 595 | |
| Mean B-2 | 663 | 0 | 687 | 1111 | 0.62 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in lbf

| ANCHOR | Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|---|
| #4 - LDA - Sliding X Anchor | 31A | 187 | 364 | 200 | 595 | |
| 1" Nylon Tubular Webbing | 31B | 0 | 1815 | 1672 | 3163 | 11.00 |
| Legs - 30cm (12") 21cm (8.5") 30cm (12") | 32A | 194 | 370 | 182 | 595 | |
| | 32B | 0 | 1775 | 1597 | 3044 | 11.00 |
| #1 #2 #3 | 33A | 193 | 365 | 190 | 595 | |
|  | 33B | 0 | 1950 | 1613 | 3233 | 10.75 |
| | 34A | 200 | 370 | 175 | 595 | |
| | 34B | 0 | 1912 | 1571 | 3168 | 10.75 |
| | 35A | 199 | 357 | 197 | 595 | |
| | 35B | 0 | 1771 | 1668 | 3116 | 11.00 |
| | Mean A | 195 | 365 | 189 | 595 | |
| | Mean B-1 | 0 | 1845 | 1624 | 3145 | 10.90 |
| | 36A | 165 | 319 | 213 | 595 | |
| | 36B | 1150 | 0 | 1968 | 2562 | 6.12 |
| | 37A | 179 | 314 | 207 | 595 | |
| | 37B | 1337 | 0 | 2135 | 2861 | 6.25 |
| | 38A | 181 | 315 | 204 | 595 | |
| | 38B | 1258 | 0 | 2073 | 2743 | 6.00 |
| | 39A | 171 | 315 | 214 | 595 | |
| | 39B | 1187 | 0 | 2077 | 2694 | 6.00 |
| | 40A | 175 | 303 | 224 | 595 | |
| | 40B | 1168 | 0 | 2051 | 2657 | 6.25 |
| | Mean A | 174 | 313 | 212 | 595 | |
| | Mean B-2 | 1220 | 0 | 2061 | 2703 | 6.12 |

#4

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in lbf

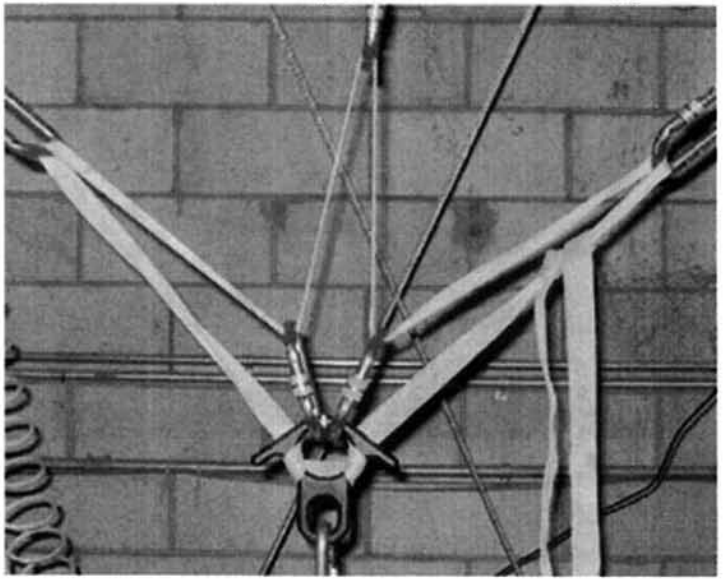
**ANCHOR**

#5 - LDA - Figure Eight Descender

1" Nylon Tubular Webbing

Legs - 30cm (12") 26cm (10.5") 30cm (12")

#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|
| 41A | 239 | 306 | 197 | 595 | |
| 41B | 0 | 2027 | 1722 | 3451 | 11.50 |
| 42A | 220 | 320 | 195 | 595 | |
| 42B | 0 | 1962 | 1740 | 3391 | 11.50 |
| 43A | 257 | 298 | 187 | 595 | |
| 43B | 0 | 2050 | 1695 | 3446 | 11.75 |
| 44A | 238 | 310 | 190 | 595 | |
| 44B | 0 | 2069 | 1726 | 3493 | 11.50 |
| 45A | 238 | 309 | 192 | 595 | |
| 45B | 0 | 1960 | 1682 | 3348 | 12.00 |
| Mean A | 238 | 309 | 192 | 595 | |
| Mean B-1 | 0 | 2014 | 1713 | 3426 | 11.65 |
| 46A | 195 | 281 | 219 | 595 | |
| 46B | 1989 | 0 | 1915 | 3269 | 7.00 |
| 47A | 198 | 278 | 218 | 595 | |
| 47B | 2073 | 0 | 1970 | 3394 | 7.25 |
| 48A | 203 | 283 | 206 | 595 | |
| 48B | 1922 | 0 | 1957 | 3254 | 6.25 |
| 49A | 198 | 277 | 218 | 595 | |
| 49B | 1869 | 0 | 1996 | 3244 | 6.25 |
| 50A | 199 | 274 | 222 | 595 | |
| 50B | 2067 | 0 | 2052 | 3461 | 7.00 |
| Mean A | 199 | 279 | 217 | 595 | |
| Mean B-2 | 1984 | 0 | 1978 | 3324 | 6.75 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in lbf

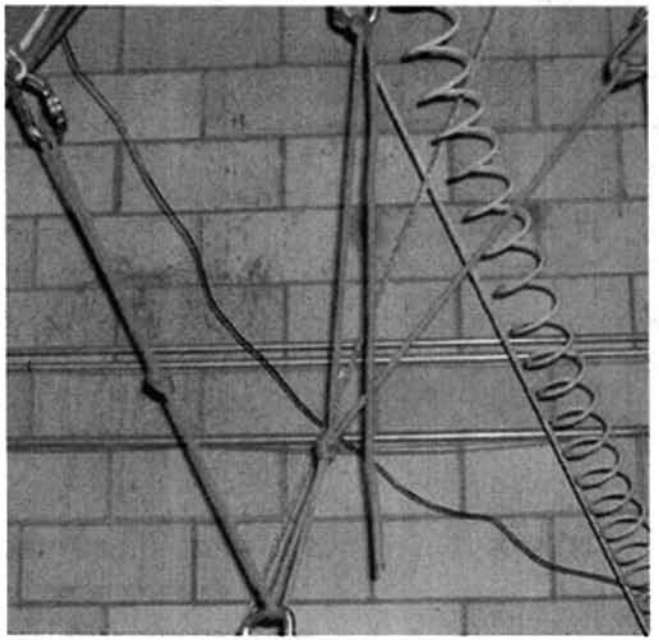
**ANCHOR**

#6 - LDA - Equalette (Climbing Anchors)

8 mm Nylon Cord

Legs - 30cm (12") 20cm (8")

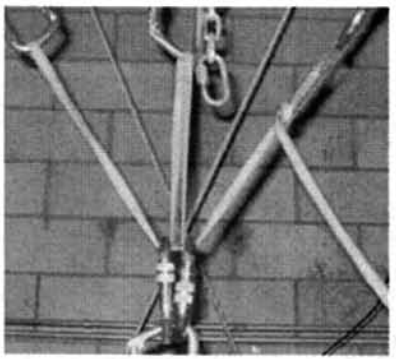
#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|
| 51A | 365 | 70 | 252 | 595 | |
| 51B | 0 | 1943 | 659 | 2512 | 22.50 |
| 52A | 344 | 89 | 252 | 595 | |
| 52B | 0 | 2193 | 728 | 2824 | 22.75 |
| 53A | 351 | 77 | 257 | 595 | |
| 53B | 0 | 2273 | 784 | 2960 | 23.50 |
| 54A | 309 | 120 | 252 | 595 | |
| 54B | 0 | 2222 | 773 | 2897 | 24.25 |
| 55A | 289 | 129 | 263 | 595 | |
| 55B | 0 | 1753 | 719 | 2364 | 24.00 |
| Mean A | 332 | 97 | 250 | 595 | |
| Mean B-1 | 0 | 2077 | 733 | 2711 | 23.40 |
| 56A | 279 | 233 | 148 | 595 | |
| 56B | 576 | 0 | 380 | 831 | 1.25 |
| 57A | 276 | 240 | 142 | 595 | |
| 57B | 593 | 0 | 392 | 857 | 1.00 |
| 58A | 275 | 242 | 141 | 595 | |
| 58B | 601 | 0 | 396 | 867 | 0.75 |
| 59A | 277 | 241 | 140 | 595 | |
| 59B | 609 | 0 | 400 | 878 | 1.00 |
| 60A | 267 | 250 | 138 | 595 | |
| 60B | 607 | 0 | 406 | 883 | 1.00 |
| Mean A | 275 | 241 | 142 | 595 | |
| Mean B-2 | 597 | 0 | 395 | 863 | 1.00 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
Force in lbf

| ANCHOR | Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|---|
| #7 - LDA - 3-point Webbing Anchor | 61A | 183 | 265 | 205 | 595 | |
| .5" Nylon/Spectra Webbing | 61B | 0 | 2470 | 1862 | 4266 | 8.75 |
| Legs - 30cm (12") 25cm (10") 30cm (12") | 62A | 199 | 273 | 179 | 595 | |
|  | 62B | 0 | 2374 | 1717 | 4028 | 9.00 |
| | 63A | 240 | 221 | 198 | 595 | |
| | 63B | 0 | 2336 | 1462 | 3745 | 8.50 |
| | 64A | 208 | 262 | 181 | 595 | |
| | 64B | 0 | 1947 | 1358 | 3260 | 9.25 |
| | 65A | 203 | 255 | 193 | 595 | |
| | 65B | | | | | Fail |
| | Mean A | 207 | 255 | 191 | 595 | |
| | Mean B-1 | 0 | 2282 | 1600 | 3825 | 8.88 |

**CMC Rescue**
**Multi-point Anchor Tests**
**2007**
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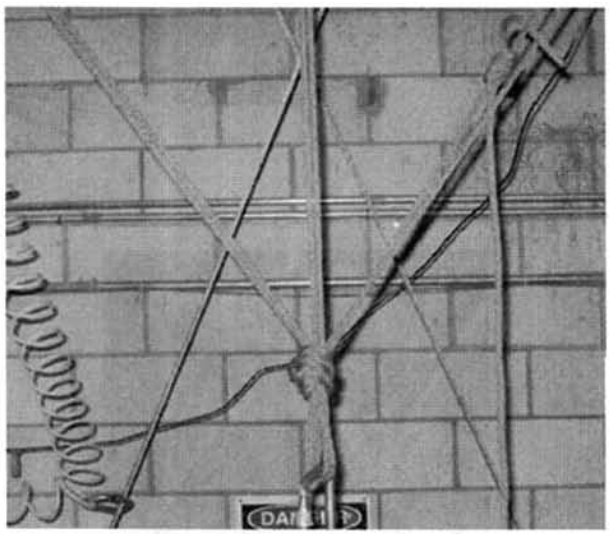
**ANCHOR**

#8 - LSA - Cordelette

8 mm Nylon Cord

#1 #2 #3



#4

| Test # | MF on #1 | MF on #2 | MF on #3 | MF on #4 | Extension " |
|---|---|---|---|---|---|
| 66A | 190 | 263 | 216 | 595 | |
| 66B | 0 | 707 | 118 | 800 | 0.75 |
| 67A | 203 | 243 | 228 | 595 | |
| 67B | 0 | 728 | 127 | 828 | 1.00 |
| 68A | 205 | 239 | 229 | 595 | |
| 68B | 0 | 738 | 126 | 836 | 1.25 |
| 69A | 205 | 239 | 229 | 595 | |
| 69B | 0 | 741 | 127 | 842 | 1.00 |
| 70A | 209 | 232 | 232 | 595 | |
| 70B | 0 | 747 | 130 | 850 | 1.00 |
| Mean A | 202 | 243 | 227 | 595 | |
| Mean B-1 | 0 | 732 | 126 | 831 | 1.00 |
| 71A | 257 | 168 | 271 | 595 | |
| 71B | | | | | |
| 72A | 126 | 372 | 146 | 595 | |
| 72B | | | | | |
| 73A | 134 | 332 | 183 | 595 | |
| 73B | | | | | |
| 74A | 190 | 263 | 216 | 595 | |
| 74B | | | | | |
| 75A | | | | | |
| 75B | | | | | |
| Mean A | 176 | 283 | 204 | 595 | |
| | | | | | |