MAXIMUM REACH ENTERPRISES
1853 Wellington Court
Henderson, NV 89014
Ph: 702 547 1564
kent.goodman @ cox.net
www.maximumreach.com

08 August 2013

# YANBU LIFT
# AND
# TRANSPORTATION OF THE LIFT CRANE

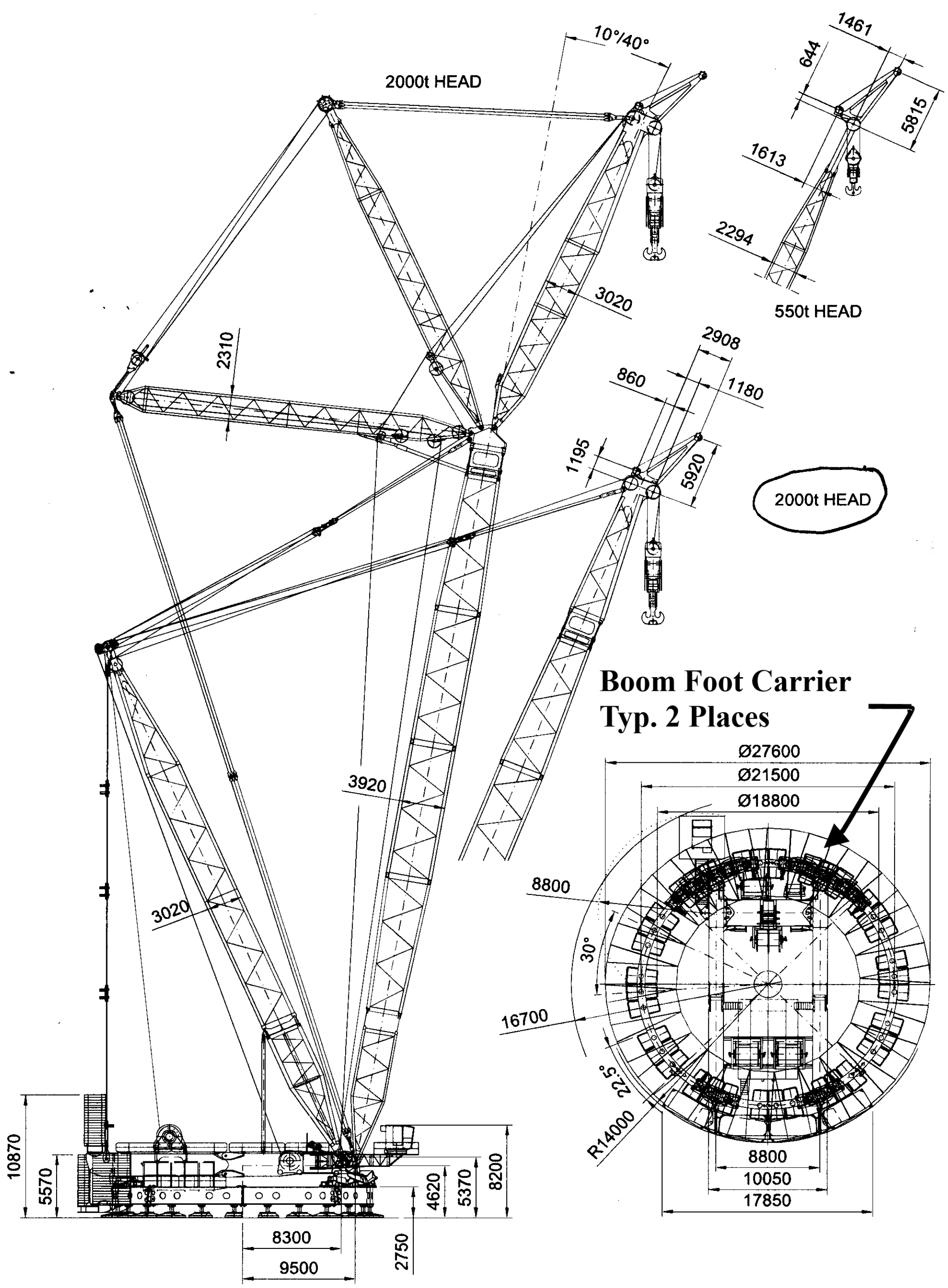
This presentation is for a lift that took place in Yanbu, Saudi Arabia by Van Seumeren for the Fluor Corporation in October, 1998. A PT50 Platform Twin Ringer was used. People in the rigging industry call this lift crane a platform twin ringer crane. It does not have a twin ring but it does have a twin boom in an A-frame shape. The twin boom does three important things, 1) there are two booms now lifting the load providing more strength, 2) it provides greater side stability, 3) the A-frame shape allows the boom foot carriers to be moved off center of the ring and moved around to the sides, thus distributing the load to the ring in a more effective way and allowing a much lower ground bearing pressure (GBP) under the pads/mats.

The photo below was downloaded from the Mammoet.com website and shows a twin ringer in the same configuration on a lift similar to the one in this presentation. Remember that Van Seumeren bought out Mammoet but chose to use the Mammoet name for the new company because it is a more recognized brand name. The photo is presented here just to show an overall view of the ringer crane. I'm hoping this will give the reader a mental picture of the different crane components as the presentation unfolds.

The drawing below shows the general outline of the crane in an elevation view. The top of the ring in the plan view shows how the boom foot carriers are located around the side of the ring, not directly under the centerline of the twin booms. As stated above, this distributes the load from the twin booms down around a greater length of the ring, hence a lower GBP under the pad/mats.

MAMMOET

PT50



The sheet below shows the capacity chart used for the lift in this presentation.

# MAMMOET

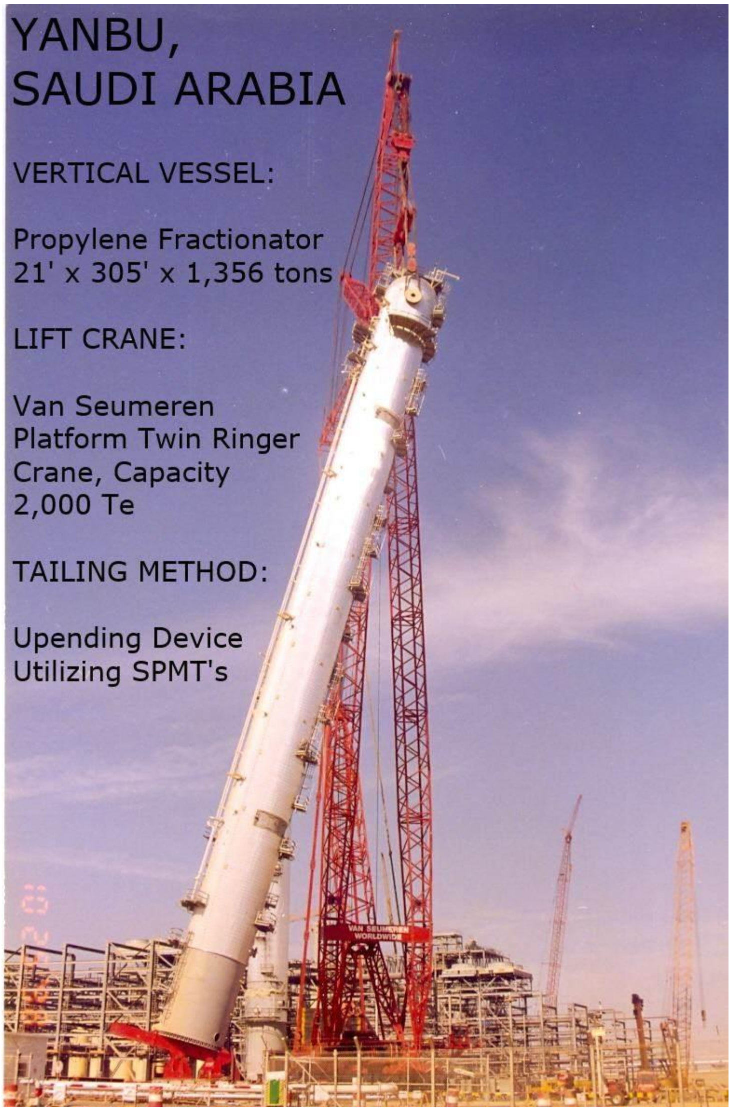
## PT50 (SWSL)

**Ring diameter:** 21.5m
**Boom angle:** 80 / 86°
**Ballast:** 1500t

**Mainboom with luffing jib and superlift (2000t head)**

| Boom length | Boom angle | Jib length | Radius in meters | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 | 50 | 54 | 58 | 62 | 66 | 70 | 74 | 78 | 82 | 86 | 89.3 |
| 66.4 | 86 | 29.7 | 1531 | 1250 | 1054 | 911 | 776 | 665 | 572 | 490 | 416 | 342 | 238 | | | | | | | | | | | | | |
| | | 35.7 | | 1345 | 1134 | 979 | 847 | 737 | 646 | 570 | 502 | 443 | 389 | 337 | 284 | 205 | | | | | | | | | | |
| | | 41.7 | | 1400 | 1174 | 1010 | 883 | 777 | 687 | 612 | 548 | 492 | 442 | 397 | 356 | 316 | 238 | | | | | | | | | |
| | | 47.7 | | | 1149 | 992 | 872 | 776 | 698 | 634 | 579 | 533 | 493 | 458 | 419 | 384 | 321 | 261 | 162 | | | | | | | |
| | | 53.7 | | | | 1002 | 890 | 792 | 712 | 647 | 591 | 544 | 502 | 466 | 434 | 403 | 343 | 291 | 244 | 188 | | | | | | |
| | | 59.7 | | | | 778 | 754 | 732 | 710 | 656 | 599 | 550 | 507 | 472 | 438 | 409 | 357 | 308 | 266 | 227 | 188 | 120 | | | | |
| | 80 | 29.7 | | | | | | 1135 | 973 | 848 | 746 | 642 | 555 | 476 | 402 | 321 | | | | | | | | | | |
| | | 35.7 | | | | | | | 1045 | 917 | 813 | 713 | 629 | 558 | 493 | 436 | 330 | | | | | | | | | |
| | | 41.7 | | | | | | | | 947 | 837 | 748 | 668 | 599 | 538 | 485 | 393 | 314 | 205 | | | | | | | |
| | | 47.7 | | | | | | | | | 826 | 740 | 669 | 608 | 558 | 515 | 445 | 381 | 319 | 256 | | | | | | |
| | | 53.7 | | | | | | | | | | 758 | 684 | 623 | 571 | 526 | 454 | 396 | 343 | 293 | 245 | 174 | | | | |
| 78.4 | 86 | 29.7 | 1600 | 1354 | 1129 | 966 | 831 | 711 | 610 | 524 | 447 | 374 | 294 | | | | | | | | | | | | | |
| | | 35.7 | | 1457 | 1214 | 1039 | 900 | 782 | 683 | 601 | 531 | 468 | 412 | 359 | 308 | 248 | | | | | | | | | | |
| | | 41.7 | | | 1259 | 1078 | 939 | 821 | 724 | 643 | 575 | 515 | 462 | 416 | 373 | 334 | 256 | | | | | | | | | |
| | | 47.7 | | | 1230 | 1054 | 919 | 814 | 729 | 659 | 601 | 552 | 510 | 472 | 436 | 399 | 333 | 274 | 187 | | | | | | | |
| | | 53.7 | | | | 1025 | 940 | 830 | 744 | 673 | 613 | 563 | 519 | 482 | 449 | 417 | 355 | 303 | 255 | 204 | | | | | | |
| | | 59.7 | | | | | 764 | 742 | 721 | 688 | 627 | 575 | 530 | 491 | 457 | 427 | 369 | 319 | 275 | 236 | 197 | 136 | | | | |
| | 80 | 29.7 | | | | | | | 1017 | 930 | 854 | 753 | 648 | 559 | 480 | 406 | | | | | | | | | | |
| | | 35.7 | | | | | | | | 944 | 870 | 805 | 719 | 634 | 561 | 497 | 386 | 275 | | | | | | | | |
| | | 41.7 | | | | | | | | | 872 | 805 | 749 | 674 | 602 | 541 | 440 | 355 | 275 | | | | | | | |
| | | 47.7 | | | | | | | | | | 823 | 749 | 675 | 615 | 564 | 482 | 418 | 352 | 291 | 205 | | | | | |
| | | 53.7 | | | | | | | | | | | 758 | 687 | 625 | 573 | 489 | 426 | 371 | 319 | 270 | 220 | | | | |
| | | 59.7 | | | | | | | | | | | | 695 | 632 | 579 | 495 | 431 | 380 | 333 | 289 | 249 | 210 | 152 | | |
| 90.4 | 86 | 29.7 | | 1477 | 1214 | 1028 | 888 | 757 | 649 | 557 | 477 | 403 | 328 | | | | | | | | | | | | | |
| | | 35.7 | | 1515 | 1307 | 1106 | 959 | 827 | 721 | 633 | 558 | 492 | 434 | 380 | 329 | 274 | | | | | | | | | | |
| | | 41.7 | | | 1336 | 1147 | 994 | 870 | 761 | 674 | 601 | 538 | 483 | 434 | 390 | 349 | 272 | | | | | | | | | |
| | | 47.7 | | | | 1124 | 970 | 855 | 762 | 687 | 625 | 572 | 526 | 487 | 452 | 413 | 345 | 286 | 205 | | | | | | | |
| | | 53.7 | | | | | 992 | 873 | 778 | 701 | 637 | 583 | 537 | 497 | 462 | 431 | 367 | 312 | 264 | 216 | | | | | | |
| | | 59.7 | | | | | 775 | 751 | 730 | 707 | 652 | 595 | 548 | 506 | 471 | 439 | 380 | 328 | 284 | 243 | 205 | 149 | | | | |
| | 80 | 29.7 | | | | | | | | 872 | 803 | 741 | 689 | 643 | 563 | 484 | 330 | | | | | | | | | |
| | | 35.7 | | | | | | | | | 821 | 759 | 706 | 659 | 617 | 564 | 442 | 336 | | | | | | | | |
| | | 41.7 | | | | | | | | | | 759 | 703 | 655 | 613 | 576 | 490 | 398 | 318 | 210 | | | | | | |
| | | 47.7 | | | | | | | | | | | 700 | 652 | 610 | 574 | 512 | 450 | 386 | 322 | 259 | | | | | |
| | | 53.7 | | | | | | | | | | | | 646 | 605 | 569 | 507 | 456 | 400 | 346 | 295 | 247 | 177 | | | |
| | | 59.7 | | | | | | | | | | | | | 624 | 586 | 521 | 466 | 409 | 358 | 311 | 269 | 230 | 186 | | |
| 102 | 86 | 29.7 | | 1300 | 1178 | 1074 | 944 | 807 | 689 | 592 | 507 | 431 | 358 | 273 | | | | | | | | | | | | |
| | | 35.7 | | | 1211 | 1083 | 970 | 876 | 760 | 666 | 586 | 517 | 455 | 400 | 348 | 296 | | | | | | | | | | |
| | | 41.7 | | | | 1078 | 965 | 871 | 793 | 706 | 628 | 562 | 503 | 452 | 406 | 363 | 286 | 198 | | | | | | | | |
| | | 47.7 | | | | 1095 | 980 | 885 | 801 | 719 | 652 | 594 | 546 | 504 | 467 | 428 | 358 | 296 | 232 | | | | | | | |
| | | 53.7 | | | | | 990 | 894 | 815 | 735 | 666 | 607 | 558 | 515 | 478 | 445 | 378 | 322 | 273 | 225 | 151 | | | | | |
| | | 59.7 | | | | | | 762 | 739 | 718 | 678 | 618 | 566 | 523 | 485 | 452 | 391 | 337 | 291 | 250 | 212 | 169 | | | | |
| | 80 | 29.7 | | | | | | | | | 757 | 699 | 649 | 604 | 566 | 532 | 410 | | | | | | | | | |
| | | 35.7 | | | | | | | | | | 695 | 645 | 602 | 564 | 530 | 472 | 388 | 249 | | | | | | | |
| | | 41.7 | | | | | | | | | | | 640 | 598 | 560 | 527 | 469 | 422 | 358 | 276 | | | | | | |
| | | 47.7 | | | | | | | | | | | | 619 | 579 | 543 | 482 | 433 | 392 | 348 | 292 | 207 | | | | |
| | | 53.7 | | | | | | | | | | | | | 573 | 538 | 478 | 428 | 388 | 354 | 316 | 270 | 221 | | | |
| | | 59.7 | | | | | | | | | | | | | | 532 | 473 | 424 | 385 | 350 | 321 | 288 | 249 | 210 | 157 | |
| 114.5 | 86 | 29.7 | | | 934 | 854 | 785 | 723 | 667 | 617 | 538 | 459 | 386 | 309 | | | | | | | | | | | | |
| | | 35.7 | | | 937 | 874 | 807 | 746 | 692 | 644 | 601 | 542 | 478 | 420 | 367 | 315 | | | | | | | | | | |
| | | 41.7 | | | | 875 | 817 | 759 | 707 | 660 | 617 | 578 | 525 | 471 | 423 | 379 | 300 | 219 | | | | | | | | |
| | | 47.7 | | | | | 823 | 773 | 723 | 676 | 635 | 597 | 557 | 521 | 484 | 443 | 370 | 308 | 246 | | | | | | | |
| | | 53.7 | | | | | 818 | 772 | 728 | 682 | 642 | 604 | 564 | 528 | 494 | 460 | 390 | 332 | 281 | 233 | 166 | | | | | |
| | | 59.7 | | | | | | 767 | 727 | 684 | 643 | 601 | 559 | 523 | 490 | 461 | 402 | 346 | 299 | 257 | 218 | 178 | | | | |
| | 80 | 29.7 | | | | | | | | | | 641 | 595 | 555 | 520 | 489 | 434 | 331 | | | | | | | | |
| | | 35.7 | | | | | | | | | | | 616 | 574 | 537 | 503 | 447 | 400 | 329 | | | | | | | |
| | | 41.7 | | | | | | | | | | | | 569 | 532 | 499 | 444 | 397 | 360 | 310 | 211 | | | | | |
| | | 47.7 | | | | | | | | | | | | | 528 | 495 | 441 | 395 | 358 | 326 | 298 | 256 | | | | |
| | | 53.7 | | | | | | | | | | | | | | 490 | 435 | 391 | 354 | 322 | 295 | 271 | 241 | 177 | | |
| | | 59.7 | | | | | | | | | | | | | | | 430 | 387 | 350 | 319 | 292 | 268 | 247 | 223 | 184 | 128 |

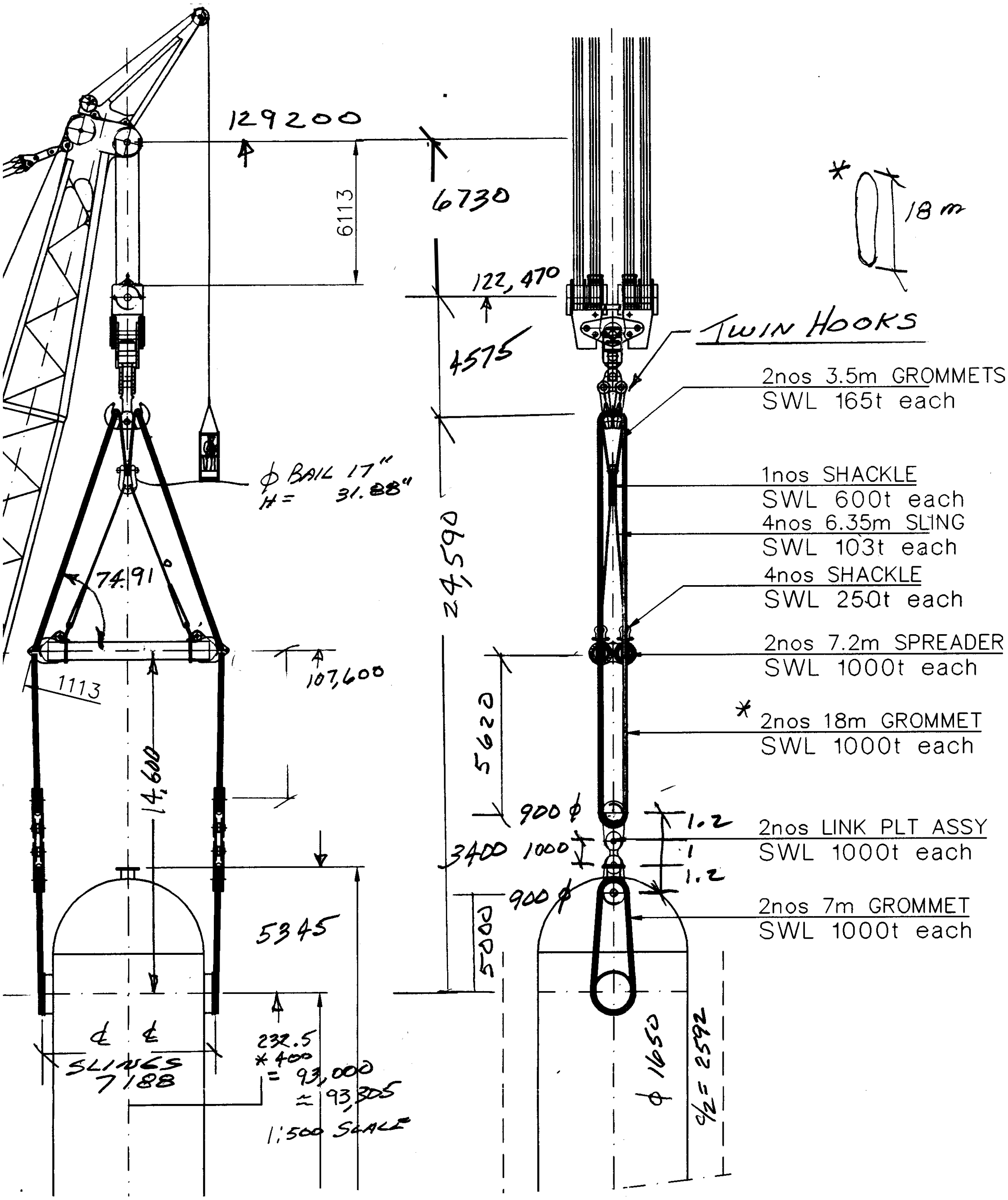
The photo below shows the vertical vessel being upended utilizing the PT50 Ringer lift crane and an upending device mounted on self-propelled modular trailer's (SPMT's) for tailing.  Some companies call the trailers self-propelled platform trailer's (SPPT's).  The 1,356 tons (1,232.9 Te) is just the weight of the vessel.




The Crane and vessel data for this lift is shown below:

| PLATFORM RINGER HEAVY DUTY SWSL | | PLACE 2C-1504B |
|---|---|---|
| MAIN BOOM | (m) | 90.4 |
| FLY JIB | (m) | 35.7 |
| MAINBOOM ANGLE | (°) | 86 |
| RINGDIAMETER | (m) | 21.5 |
| COUNTERWEIGHT | (Te) | 180 |
| BALLAST ON RING | (Te) | 1500 |
| RADIUS | (m) | 26 |
| CAPACITY | (Te) | 1515 |
| MAX. LOAD | (Te) | 1232.9 |
| BLOCK WEIGHT | (Te) | 70 |
| RIGGING | (Te) | 46.3 |
| TOTAL | (Te) | 1349.2 |
| Max. RINGPRESSURE | (Te/m²) | 31.6 |
| PERCENTAGE OF SWL | (%) | 89.1 |

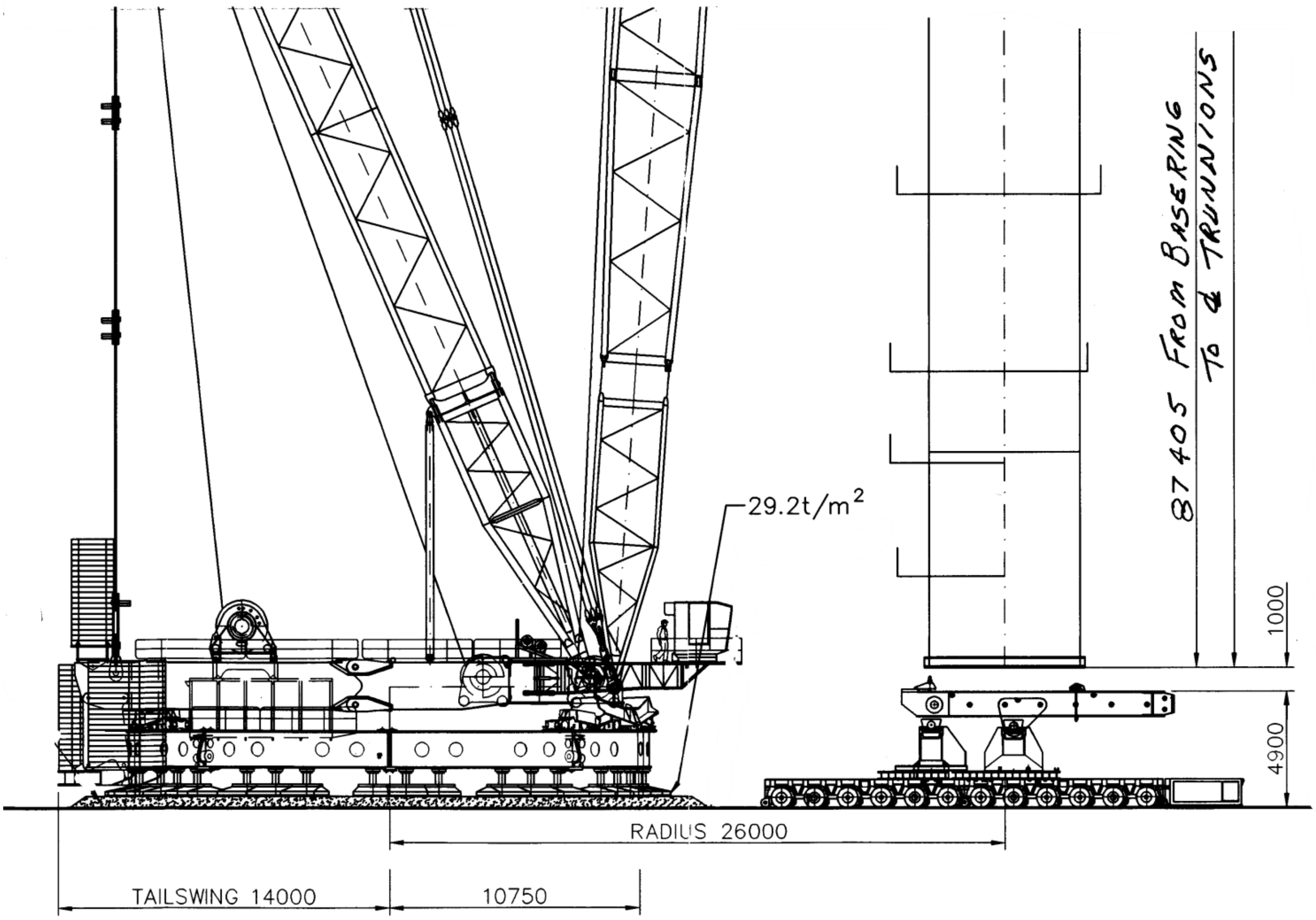
The rigging hookup is shown in the drawing below.




NOTE:

1. The 129,000 mm elevation show at the top in hand written numbers is measured from grade with the vertical vessel positioned 1,000 mm above the upending device. These figures were used to verify that there was enough head room at the set position.
2. The load block has twin hooks and the main lifting grommet goes over both prongs on each side. The ϕ of the two prongs on the hooks is estimated at 35".
3. The main lift grommets are 246 mm ϕ (9.68") x 1,000 Te SWL in a straight pull.
4. Support slings were used to keep the spreader bars at the required level.

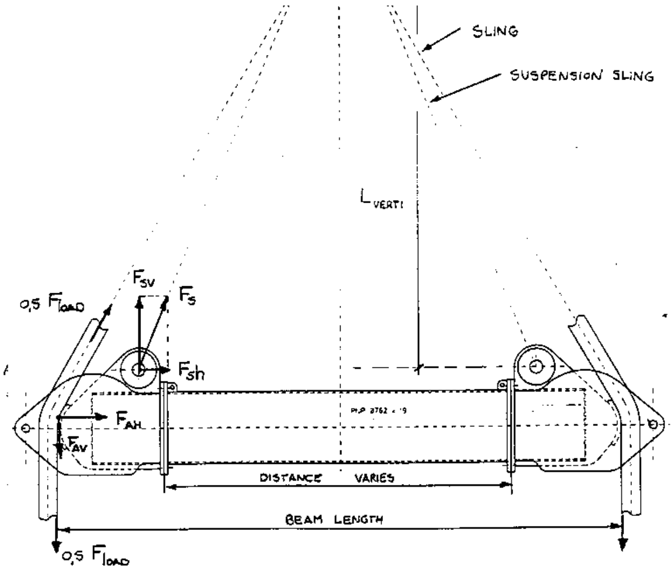
The drawing below shows the base of the crane and the bottom of the vertical vessel 1,000 mm above the upending device.




The allowable GBP for the area was approximately 20,000 psf. The actual GBP was 29.2 Te/m² which is ≈ 6,000 psf. Therefore, the safety factor for the GBP was 3.33:1 ===➔ GOOD

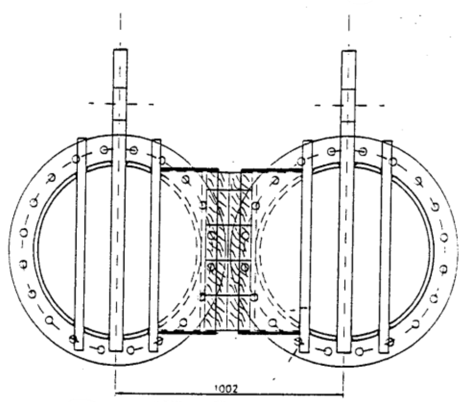
Any differential settlement of the pads was taken care of by the jacks being automatically adjusted in height to keep the ring level.

The drawing below shows the side view of the two 30” ϕ x 0.75” wall thickness x 1,000 Te capacity pipe spreader bars that were used for the lift. The two spreader bars were used side by side with wooden slide plates on the inside of each spreader bar to allow them to align themselves with each other.

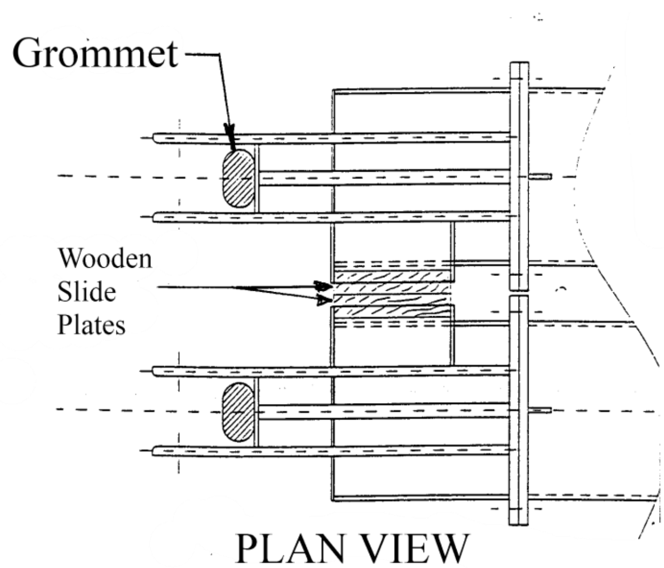



**SIDE VIEW**

Details of the ends of the two spreader bars is shown below.



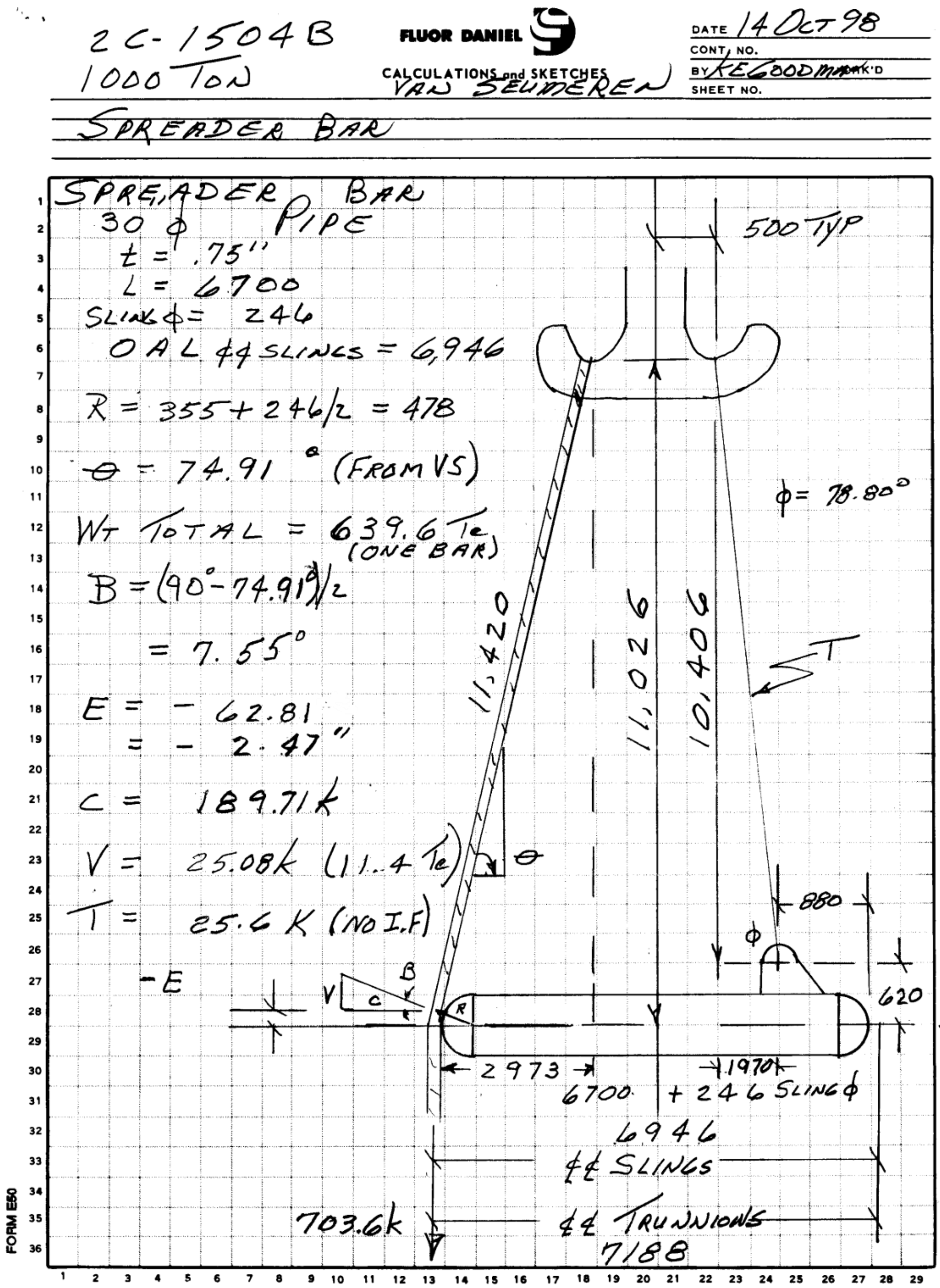

END VIEW




PLAN VIEW

In order to check the combined stress in the two spreader bars, the eccentricity E had to be calculated. The calculation sheet below shows how “E” was calculated and found to be -2.47”. The E will then be used in the computer program in calculating the combined stress of the spreader bars. Note that R is measured as the radius of the curved end plate + ½ ϕ grommet. I used the word “sling” below instead of Grommet because it is easy to write and also I was treating one part of the grommet as a sling. Ordinarlly, a 15” radius for the curved end plate would be used for a 30” ϕ pipe, but VS used a different curved end plate that had a radius of 355 mm (13.98”) and a ϕ of 27.95”.

The load carried by one spreader bar was 0.5*(weight of the vessel + rigging) = 0.5*(1,232.9 Te + 46.3 Te) = 639.6 Te




Note in the printout sheet below that the eccentricity E of -2.47” was used and that the Combined Stress Check for the load on one spreader bar was 0.36 which means that only about a third of the strength of the bar was being used. This program for designing spreader bars with variable “E” is attached for your information.

The total load to be lifted by one spreader bar is 639.6 Te = 1,407.12 kips

**Maximum Reach**
Henderson, Nevada
Client: YANPET
Project: Yanpet Refinery
Location: Yanbu, Saudi Arabia

**SPREADER BAR DESIGN**
For pipe or beams with curved end plates with variable eccentricity "e"
Also applicable to Versa Bars when eccentricity "e" is set to zero
**With or without the CG centered between lift lugs**
With or without support slings at each end

**Item: 2C-1504B**
**Input Data** Date: 10/14/1998 Contract # 334455

| | | | |
|---|---|---|---|
| Total load to be lifted, include rigging | 1407.12 | kips | One spreader bar |
| Angle of the left sling, See Note 1 | 74.91 | degrees | NOTE 1: When the CG is not centered on |
| Horiz dist., brg to brg on Duplex hook | 39.37 | in | the spreader bar, use the left sling angle |
| Distance from the CG to cl left lug | 136.73 | in | as the smaller of the two sling angles. |
| Distance from the CG to cl right lug | 136.73 | in | Recommend using 60 deg min. |
| Length of spreader bar, c/c lugs | 273.46 | in | |
| Load eccentricity, left side e | -2.47 | | Use +e if eccentricity is below the cl of the bar |
| Load eccentricity, right side, e | -2.47 | | Use +e if eccentricity is below the cl of the bar |
| Nominal pipe dia or beam size | 30" Ø Pipe | | I.E., 14" dia pipe, W18 x 46, H300x200x57, etc. |
| Pipe schedule, if applicable | std | | |
| Radius of Gyration, r | 10.34 | in | |
| Cross-section area Ap | 68.92 | in^2 | |
| Section Modulus, Sx | 491.40 | in^3 | |
| Moment of inertia Ix | 7371.00 | in^4 | |
| Weight per foot, Wp | 234.00 | lbs/ft | |
| Effective length factor, K | 1.00 | | Use K = 1 for spreader bars |
| Yield stress Fy | 36.00 | ksi | |
| Modulus of elasticity E | 29000.00 | ksi | |
| Impact factor IF | 80.00 | % | Recommend 80% |
| **Output Data** | | | |
| Vertical load, left end, R1 | 703.56 | kips | |
| Vertical load, right end, R2 | 703.56 | kips | |
| Length of left sling above bar | 449.59 | in | |
| Length of right sling above bar | 449.59 | in | |
| Rigging height, cl bar to brg. on hook | 434.09 | in | |
| Sling angle(horiz), right side | 74.91 | degrees | Recommend 60 deg min. |
| Tension in left sling above bar | 728.69 | kips | |
| Tension in right sling above bar | 728.69 | kips | |
| Kl/r | 26.45 | | if < 120, OK |
| Compression in bar, Hc | 189.70 | kips | |
| Col elastic slender ratio, Cc | 126.10 | | |
| Axial stress, fa | 2.75 | ksi | w/o Impact Factor |
| Allowable axial stress, Fa | 20.19 | ksi | if Kl/r < Cc |
| Moment due to Hc, left side | 468.57 | in-kip | |
| Moment due to Hc, right side | 468.57 | in-kip | A negative value indicated the bar is |
| Moment due to Wp, Mp | 182.28 | in-kip | being bowed up at the center or middle |
| Net bending moment, left side | 650.84 | in-kip | |
| Net bending moment, right side | 650.84 | in-kip | |
| Bending stress, left side, fb | 1.32 | ksi | w/o Impact Factor |
| Bending stress, right side, fb | 1.32 | ksi | w/o Impact Factor |
| Allowable bending stress, Fb | 21.60 | ksi | |
| Allowable Euler stress, Fe' | 213.50 | ksi | |
| Combined stress check, LEFT side | 0.36 | | < 1.0 OK (w/ IF & Kl/r < Cc) |
| Combined stress check, RIGHT side | 0.36 | | < 1.0 OK (w/ IF & Kl/r < Cc) |
| | | | Both values above must be < 1.0 |
| Tension in the LEFT support sling | 39.04 | kips | |
| Tension in the RIGHT support sling | 39.04 | kips | |

The combined stress check = 0.36 > 1.0 ===➔ GOOD

The tension in the support slings includes a 1.5 impact factor.
39.4 kips < 226 kips ( 103 Te) ===➔ GOOD

From the above printout, notice that the tension in the inclined portion of one part of the grommet is 728.69 kips. The actual SWL of each grommet is found by using the following procedure:

| | | | |
|---|---|---|---|
| The diameter of the grommet is | = 246 mm | = | 9.68” |
| The diameter of the two hooks was estimated at | | = | 35” |
| The diameter of the curved plate at the end of the bar | | = | 27.95” |
| The diameter of the sheaves in the link plate assy. | = 900 mm | = | 35.43” |
| The diameter of the trunnions is | = 1650 mm | = | 64.96” |

From the MacWhyte graph for slings bent around pins, and using the smallest diameter of 27.95”

R = pin diameter/sling diameter = 27.95”/9.68” = 2.89 &

E = 100-50/√R = 70.6 %

Therefore, the actual SWL of each grommet = 0.706*1,000 Te = 706 Te ≈ 1,553 kips

1,553 kips > 2 parts of the grommet* 728.69 kips ≈ 1,457 kips ===➔ GOOD

The photo below shows the vertical vessel being tailed up by the upending device. The vessel is at about a 70° lift angle. The tail load is being transferred from the lower pivot point to the upper pivot point.

The photo below shows the vessel in the vertical

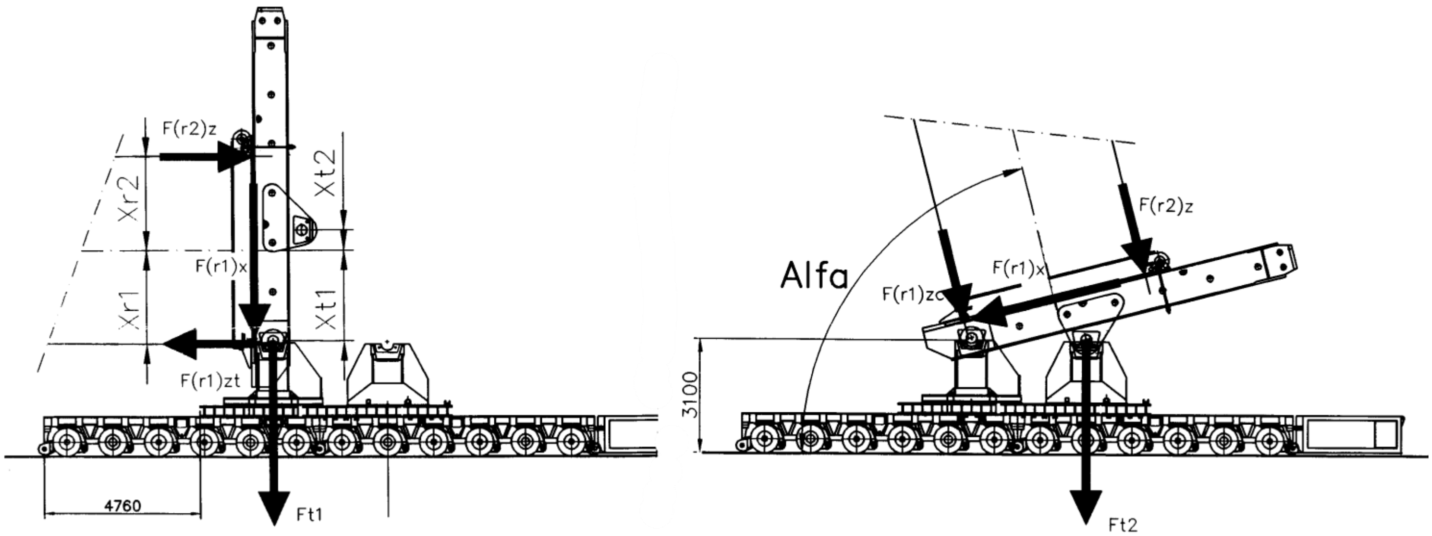

The photo below shows an overall view of the vessel in the vertical position

The photo below shows day light between the two spreader bars

The photo below shows the vessel above the upending device.  Notice the two red clamps/shear lugs that were used to keep the basering positioned correctly on the upending device.  There were also two clamps on the opposite side.  See the end view drawing of the upending device below.  The basering was also clamped to the upending device by bolts that ran through the anchor bolts holes.

As a side note, Mammoet calls the round pipe stanchions supporting the upending device "elephant stands"

The drawing on the left below shows the upending device attached to the vessel when it was in the horizontal initial pick position (IPP), & the one on the right shows the vessel at about 70°. At 70°, the tail load was transferred from the pivot or turning position at the bottom of the basering to 1' above the centerline of the vessel.




What is neat about the upending device is that at the IPP, the part of the device mounted to the basering pivots at the bottom of the base ring, thus carrying its share of the total load. At about 70 degrees, longer lugs mounted above the center of the vessel engage and the pivot or turning point then become above the center line of the vessel, thus preventing the SPMT's from carrying the full load of the vessel when it is vertical. Good engineering.

See the upending computer printouts below for more clarification.

As a side note, in the side views of the upending device and the trailers above, note that there are only three axle lines extending out past the edges of the upending device. The trailer manufactures recommend that this be a maximum of axles extending outside a saddle, a turntable, upending device, etc. This is because the bending moment from more than three axles would overstress the platform frame of the trailers at the edge of the saddle, etc. If more axle lines were needed for capacity, then a full width frame would have to be designed that would rest on the platform of the trailers, and the saddles, turntable, etc, would rest on the frame. The frame would have to be long enough so that only three axle lines extended past each end.

The printout below shows the tail load to the trailers when the pivot or turning point is at the bottom of the basering. It shows that the tail load increases as the lift angle increase to a maximum of the total lift load at 90°. The upper turning point is at 70°. Note the value of the tail load at 70° is 1,391.28 kips.

The total load used below is the weight of the vessel = 1,232.9 Te = 2,712.4 kips.

```
                 WELCOME TO MAXIMUM REACH ENTERPRISES
10-17-1998
15:57:51
THIS PROGRAM IS VESFORC2,  VERSION  1.6  REVISION DATE 1 JAN 98

THIS IS A PROGRAM FOR CALCULATING THE TOP AND TAIL FORCES
THAT OCCUR DURING THE UP/DOWN ENDING OF A VESSEL WHERE THE TAIL
POINT IS *BELOW* THE LONGITUDINAL CENTERLINE OF THE VESSEL

*****************      INPUT    DATA    *************************
CONTRACT.NUMBER              =
EQUIPMENT.NUMBER             =2C-1504B
 * TOTAL LENGTH IS FROM THE TOP LIFT POINT TO THE CL OF THE TAIL POINT
 * LOWER LENGTH IS FROM THE VESSEL C. G. TO THE CL OF THE TAIL POINT
 * OFFSET LENGTH IS FROM CL OF VESSEL TO CL OF THE TAIL POINT,
   A MINUS VALUE
TOTAL.LOAD         (KIPS)  = 2712.4
TOTAL.LENGTH       (FT   ) = 286.76
LOWER.LENGTH       (FT   ) = 154.44
OFFSET.LENGTH      (-FT  ) =-10.48

#################      OUTPUT      ##############################
```

| LIFT ANGLE (DEG) | LIFT LOAD (KIPS) | LIFT LOAD RADIAL (KIPS) | LIFT LOAD TRANSVERSE (KIPS) | TAIL LOAD (KIPS) | TAIL LOAD RADIAL (KIPS) | TAIL LOAD TRANSVERSE (KIPS) | SPAN (FT) |
|---|---|---|---|---|---|---|---|
| 0.00 | 1460.81 | 1460.81 | 0.00 | 1251.59 | 1251.59 | 0.00 | 286.76 |
| 5.00 | 1456.80 | 1451.26 | 126.97 | 1255.60 | 1250.82 | 109.43 | 284.76 |
| 10.00 | 1452.70 | 1430.63 | 252.26 | 1259.70 | 1240.57 | 218.75 | 280.58 |
| 15.00 | 1448.44 | 1399.08 | 374.88 | 1263.96 | 1220.89 | 327.14 | 274.28 |
| 20.00 | 1443.94 | 1356.86 | 493.86 | 1268.46 | 1191.96 | 433.84 | 265.88 |
| 25.00 | 1439.11 | 1304.28 | 608.20 | 1273.28 | 1153.99 | 538.11 | 255.46 |
| 30.00 | 1433.84 | 1241.74 | 716.92 | 1278.56 | 1107.27 | 639.28 | 243.10 |
| 35.00 | 1427.94 | 1169.70 | 819.04 | 1284.45 | 1052.16 | 736.73 | 228.89 |
| 40.00 | 1421.22 | 1088.72 | 913.54 | 1291.18 | 989.10 | 829.96 | 212.93 |
| 45.00 | 1413.34 | 999.38 | 999.38 | 1299.06 | 918.58 | 918.58 | 195.36 |
| 50.00 | 1403.82 | 902.36 | 1075.39 | 1308.58 | 841.14 | 1002.43 | 176.30 |
| 55.00 | 1391.89 | 798.36 | 1140.17 | 1320.51 | 757.41 | 1081.70 | 155.89 |
| 60.00 | 1376.23 | 688.12 | 1191.85 | 1336.17 | 668.08 | 1157.15 | 134.30 |
| 65.00 | 1354.38 | 572.39 | 1227.49 | 1358.02 | 573.92 | 1230.78 | 111.69 |
| 70.00 | 1321.12 | 451.85 | 1241.44 | 1391.28 | 475.85 | 1307.38 | 88.23 |
| 75.00 | 1263.15 | 326.93 | 1220.11 | 1449.25 | 375.09 | 1399.87 | 64.10 |
| 80.00 | 1133.58 | 196.84 | 1116.36 | 1578.82 | 274.16 | 1554.83 | 39.47 |
| 85.00 | 562.92 | 49.06 | 560.78 | 2149.48 | 187.34 | 2141.30 | 14.55 |
| 86.00 | 90.53 | 6.32 | 90.31 | 2621.86 | 182.89 | 2615.48 | 9.55 |
| 87.00 | -1.18 | -22.54 | -1.18 | 2713.58 | 22.54 | 2709.86 | 4.54 |
| 88.00 | -1.68 | -48.09 | -1.68 | 2714.08 | 48.09 | 2712.42 | -0.47 |
| 89.00 | -1.28 | -73.62 | -1.29 | 2713.68 | 73.62 | 2713.27 | -5.47 |
| 90.00 | 0.00 | -99.13 | 0.00 | 2712.40 | 99.13 | 2712.40 | -10.48 |

```
 NOTES:
    1. SPAN IS THE HORIZONTAL DISTANCE (+ OR -) BETWEEN THE LIFT POINT
       AND THE TAIL POINT
    2. THE PROGRAM ASSUMES THAT THE LIFT CRANE LOSES ALL LOAD ONCE THE
       CENTER OF GRAVITY CROSSES OVER THE TAIL POINT DURING UP ENDING
    3. MINUS VALUES SHOWN FOR THE LIFT LOAD & COMPONENTS INDICATES THAT
       THE FORCES ARE OPOSITE TO THEIR NORMAL DIRECTION
    4. NO IMPACT IS INCLUDED IN ABOVE VALUES
```

The printout below shows the tail load to the trailers when the pivot or turning point is at 1’ above the centerline of the vessel. It shows that the tail load decreases to zero as the lift angle increase to 90°. The upper turning point is at 70°. Note the value of the tail load at 70° is 1,239.71 kips < 1,391.28 kips.

So in summary, at the start of the lift, the tail load increases up to 1,391.28 kips for a lift angle of 70°. At that angle, the turning point is transferred to 1’ above the centerline of the vessel and the tail load drops back to 1,239.71 kips. As the lift continues, the tail load drops off in a predictable manner until it is at zero kips at a 90° lift angle. Note that the tail load drops from 1,043.18 kips at 89° to zero at 90°. The upending for the last degree must be done rather slowly.

```
            WELCOME TO MAXIMUM REACH ENTERPRISES
10-17-1998
15:55:20
THIS PROGRAM IS VESFORC1,  VERSION  1.6  REVISION DATE 1 JAN 98

THIS IS A PROGRAM FOR CALCULATING THE TOP AND TAIL FORCES
THAT OCCUR DURING THE UP/DOWN ENDING OF A VESSEL WHERE THE TAIL
POINT IS ON OR ABOVE THE LONGITUDINAL CENTERLINE OF THE VESSEL

*****************      INPUT    DATA    **************************
CONTRACT.NUMBER               =
EQUIPMENT.NUMBER              =2C-1504B
 * TOTAL LENGTH IS FROM THE TOP LIFT POINT TO THE CL OF THE TAIL POINT
 * LOWER LENGTH IS FROM THE VESSEL C. G. TO THE CL OF THE TAIL POINT
 * OFFSET LENGTH IS FROM CENTER OF VESSEL TO CENTER OF THE TAIL POINT,
   A POSITIVE VALUE
TOTAL.LOAD        (KIPS) = 2712.4
TOTAL.LENGTH      (FT  ) = 286.76
LOWER.LENGTH      (FT  ) = 154.44
OFFSET.LENGTH     (FT  ) = 1

#################      OUTPUT      ##############################
```

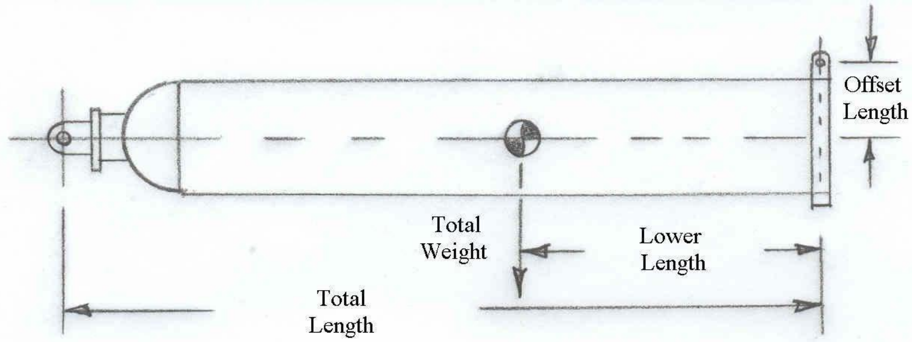
| LIFT ANGLE (DEG) | LIFT LOAD (KIPS) | LIFT LOAD RADIAL (KIPS) | LIFT LOAD TRANSVERSE (KIPS) | TAIL LOAD (KIPS) | TAIL LOAD RADIAL (KIPS) | TAIL LOAD TRANSVERSE (KIPS) | SPAN (FT) |
|---|---|---|---|---|---|---|---|
| 0.00 | 1460.81 | 1460.81 | 0.00 | 1251.59 | 1251.59 | 0.00 | 286.76 |
| 5.00 | 1461.20 | 1455.64 | 127.35 | 1251.20 | 1246.44 | 109.05 | 285.76 |
| 10.00 | 1461.58 | 1439.38 | 253.80 | 1250.82 | 1231.81 | 217.20 | 282.58 |
| 15.00 | 1461.98 | 1412.17 | 378.39 | 1250.42 | 1207.81 | 323.63 | 277.25 |
| 20.00 | 1462.40 | 1374.21 | 500.17 | 1250.00 | 1174.62 | 427.52 | 269.81 |
| 25.00 | 1462.85 | 1325.79 | 618.23 | 1249.55 | 1132.48 | 528.08 | 260.32 |
| 30.00 | 1463.33 | 1267.28 | 731.66 | 1249.07 | 1081.73 | 624.54 | 248.84 |
| 35.00 | 1463.86 | 1199.13 | 839.64 | 1248.54 | 1022.74 | 716.13 | 235.47 |
| 40.00 | 1464.47 | 1121.85 | 941.34 | 1247.93 | 955.97 | 802.16 | 220.31 |
| 45.00 | 1465.16 | 1036.03 | 1036.03 | 1247.24 | 881.93 | 881.93 | 203.48 |
| 50.00 | 1465.99 | 942.32 | 1123.02 | 1246.41 | 801.17 | 954.80 | 185.09 |
| 55.00 | 1467.02 | 841.45 | 1201.71 | 1245.38 | 714.32 | 1020.16 | 165.30 |
| 60.00 | 1468.33 | 734.16 | 1271.61 | 1244.07 | 622.04 | 1077.40 | 144.25 |
| 65.00 | 1470.10 | 621.29 | 1332.37 | 1242.30 | 525.02 | 1125.90 | 122.10 |
| 70.00 | 1472.69 | 503.69 | 1383.88 | 1239.71 | 424.01 | 1164.94 | 99.02 |
| 75.00 | 1476.89 | 382.25 | 1426.57 | 1235.51 | 319.77 | 1193.41 | 75.18 |
| 80.00 | 1485.09 | 257.88 | 1462.52 | 1227.31 | 213.12 | 1208.67 | 50.78 |
| 85.00 | 1508.79 | 131.50 | 1503.05 | 1203.61 | 104.90 | 1199.03 | 25.99 |
| 86.00 | 1520.27 | 106.05 | 1516.56 | 1192.13 | 83.16 | 1189.23 | 21.00 |
| 87.00 | 1538.90 | 80.54 | 1536.79 | 1173.50 | 61.42 | 1171.89 | 16.01 |
| 88.00 | 1574.45 | 54.95 | 1573.49 | 1137.95 | 39.71 | 1137.26 | 11.01 |
| 89.00 | 1669.22 | 29.13 | 1668.97 | 1043.18 | 18.21 | 1043.02 | 6.00 |
| 90.00 | 2712.40 | -0.00 | 2712.40 | 0.00 | 0.00 | 0.00 | 1.00 |

NOTES:

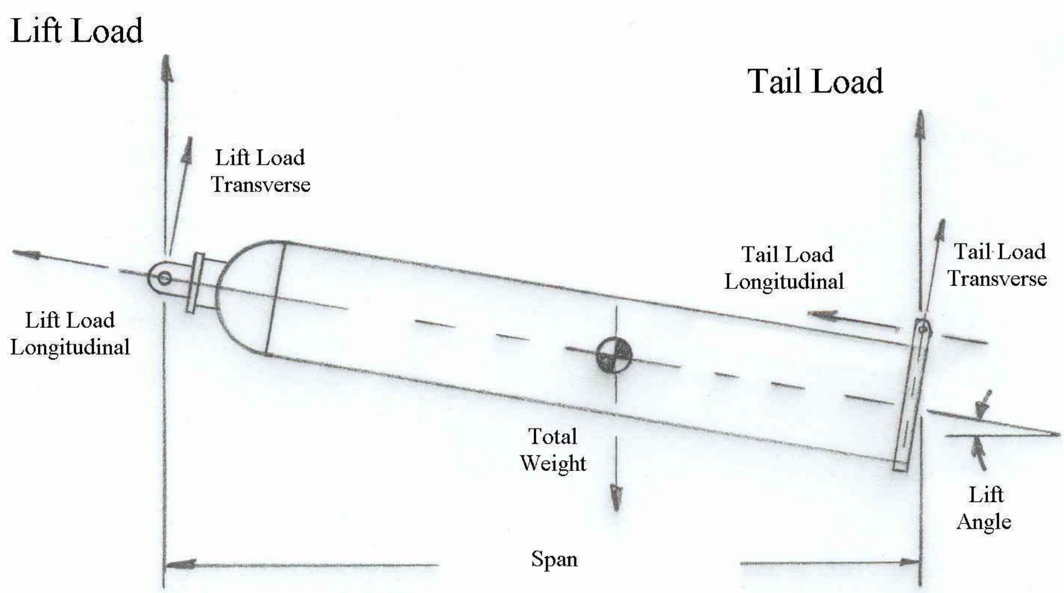
1. SPAN IS THE HORIZONTAL DISTANCE BETWEEN THE LIFT POINT AND THE TAIL POINT
2. NO IMPACT IS INCLUDED IN ABOVE VALUES

In the upending program on my website, I have changed the word "radial" to read transverse and the word "transverse" to read longitudinal.  This change is reflected in the sketch below.  I feel that the word change describes the forces involved better than the ones in this 1998 revision.  But, the output is the same.

Note that the "offset length" can be either positive or negative.  Positive when the tailing or turning point is above the centerline of the vessel or negative when it is below the centerline of the vessel.




**INPUT SKETCH FOR UPENDING**



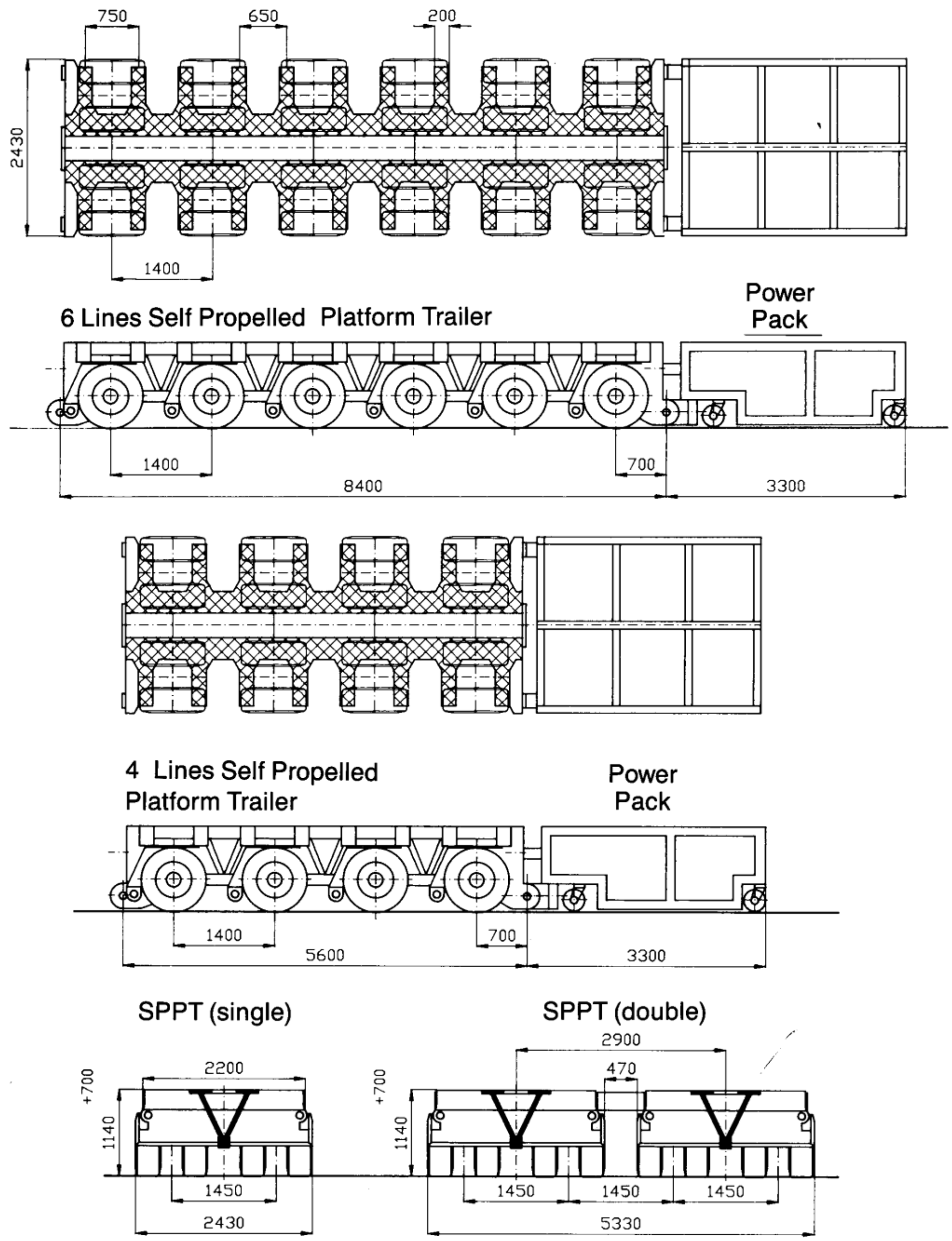

**OUTPUT SKETCH FOR UPENDING FORCES**

The cut sheet below shows the dimensions, weights and allowable axle loadings for the trailers used by VS for this lift. This information will be used later in some calculations.

**KAMAG**

**ZELFRIJDENDE PLATFORM WAGENS**
**SELFPROPELLED PLATFORM TRAILERS**

**VAN SEUMEREN HOLLAND B.V.**




**4 LINES KAMAG**

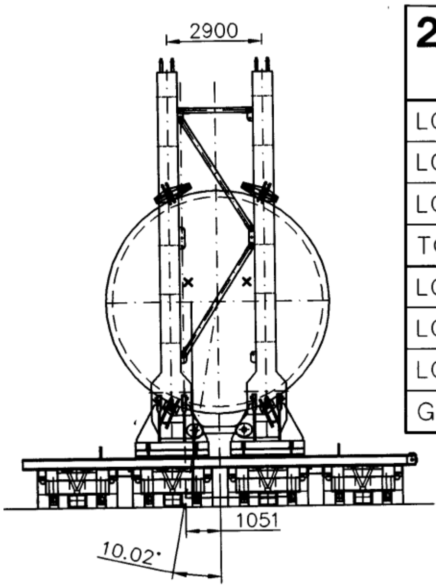
| | |
|---|---|
| Max. payload: | 120 tons |
| Own weight: | 16 tons |
| Max. axleline load: | 34 tons |
| Weight Power Pack: | 6 tons |
| Pulling force at max. load: | 22 tons |
| Max. speed at full load: | 6 km/hr |

**6 LINES KAMAG**

| | |
|---|---|
| Max. payload: | 180 tons |
| Own weight: | 22,5 tons |
| Max. axleline load: | 34 tons |
| Weight Power Pack: | 6 tons |
| Pulling force at max. load: | 22 tons |
| Max. speed at full load: | 6 km/hr |

An end view of the upending device and the trailer data are show below.

LTP means the "Lower Turning Point
UTP means the "Upper Turning Point




2C-1504B

| 2C-1504B | LTP FIELD 1 | LTP FIELD 2&3 | UTP FIELD 1 | UTP FIELD 2&3 |
|---|---|---|---|---|
| LOAD ON TRAILERSECTION (Te) | 435 | 135.5 | 111.7 | 223 |
| LOAD TRAILER (Te) | 104 | 64 | 104 | 64 |
| LOAD EQUIPMENT (Te) | 45.3 | 45.3 | 45.3 | 45.3 |
| TOTAL LOAD (Te) | 584.3 | 244.8 | 261 | 332.3 |
| LOAD / LINE (Te) | 24.3 | 20.4 | 21.8 | 27.7 |
| LOAD / AXLE (Te) | 12.15 | 10.2 | 10.9 | 13.85 |
| LOAD / WHEEL (Te) | 6.08 | 5.1 | 5.45 | 6.93 |
| GROUNDPRESSURE (Te/M2) | 7.16 | 6 | 3.5 | 8.14 |

**END VIEW** **TRAILER DATA**

In the End View drawing above, it shows an angle of 10.02°. As a rule of thumb if the angle is 8° or more, then the trailer and load are stable against side tipping.

The 10.02 ° angle was calculated by:

1. Calculating the distance from the CG to the edge of the horizontal stability triangle as 1051 mm. See figure 2 below where VS calculated it as a perpendicular distance, which is conservative. I always calculate the transverse/side distance because I reason that if the CG moves, it will be to the side and not on a diagonal. See the End View drawing above to see how it is used as the base for the triangle that will be used for figuring the stability angle.
2. The other leg of the triangle is shown as the height from ground to the centerline of the vessel. This is also conservative as the vertical distance is normally measured from the ground up to the combined CG of the load, the upending device and the trailers.
3. With the two legs of the right triangle identified, the resulting stability angle = 10.02°.

I always like to work with a 5:1 safety factor whenever possible, and this includes working with the tipping angle as well. To look at it this way, use the tipping angle and the total width of 11,130 mm for the four trailers to see how much they will be out of level on a 10.02° cross slope. The out of level = 1,936 mm. Dividing this by 5 = 387 mm = 15.25". Keeping the platform of the trailers level with in 387 mm is easy to do, so this is a very stable arrangement against side tipping.

Note in the drawing below that the trailers are plumbed in a three point hydraulic suspension mode. This means that there are 24 axle lines supporting point 1 at the top in field 1, there are 12 axle lines supporting point 2 at the bottom right and the same for point 3 at the bottom left. In the drawing, the power packs are attached to the bottom end. The hydraulic CG of each point forms the corners of the horizontal stability triangle. The lift starts out with the CG of the tail load in the top of the stability triangle in the FIELD 1 area. At 70°, the CG of the tail load transfers to the bottom or base of the stability triangle where there is much more stability of the trailers against tipping. The greater the transverse distance from the CG to a side of the stability triangle, the more stable the load/trailers. The same is true for the CG in the longitudinal direction, the direction of trailer travel.

The trailer configuration for upending the vessel is shown below.

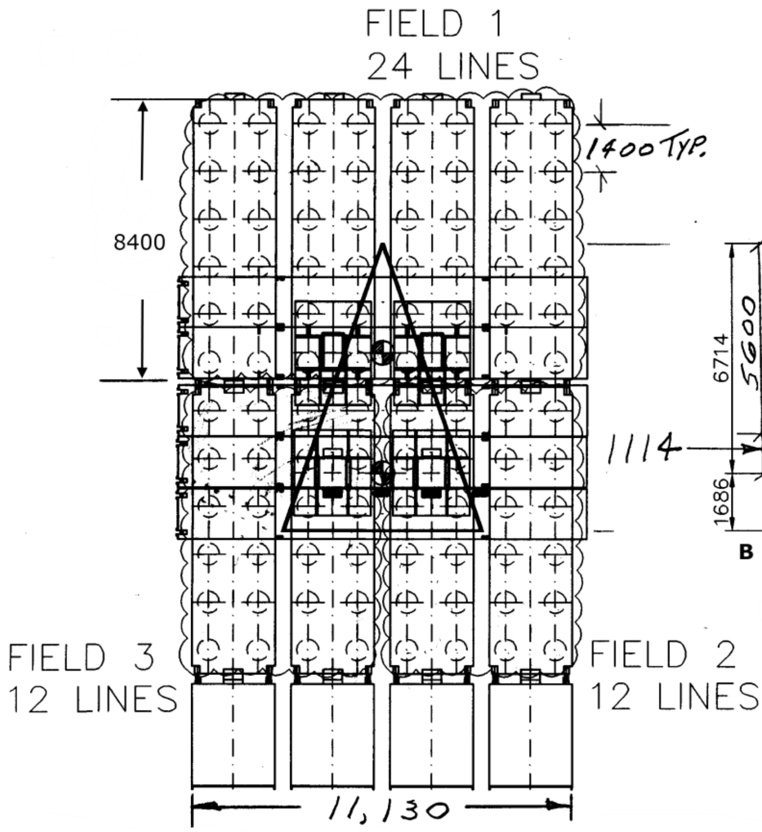



FIGURE 1

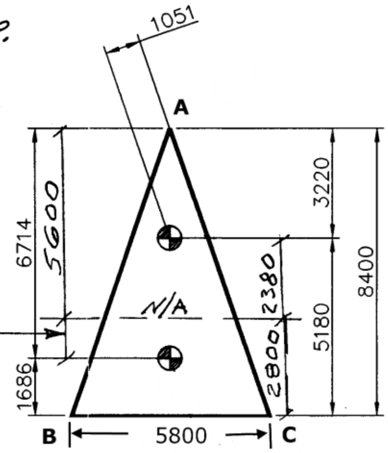



FIGURE 2

Normally, the CG of a load is placed directly over the centerline of the trailers, both in the transverse and longitudinal directions. This makes it very easy to calculate the loading to each of the three points of the stability triangle and to the axles, ie, just like calculating the lift load and tail load for a vessel in the IPP. However in this case, the lower turning point is located above the trailer centerline and the upper turning point is located below the trailer centerline. This makes calculating the loading to the three points more complex.

To verify the axle line loadings shown in the TRAILER DATA table for the **lower turning point**, the flexure formula can be used. It is shown on the next page. Review it before going through the calculations below as the same steps must be used. See the TRAILER DATA table for the loads and see Figure 2 above for the dimensions used in the calculations. The dimensions used will be in meters.

The total load to the lower turning point for fields 1, 2, & 3 is 435 + 2*135.5 + 3*45.3 = 841.90 Te

$Ix = 5.6^2 + 2*2.8^2 = 47.04\ m^2$

Mx = 841.90 * 2.38 = 2003.72 Te – m

Pa = 841.90/3 + 2003.72 * 5.6/47.04 – 0 = 519.17 Te

Pb = 841.90/3 – 2003.72 * 2.8/47.04 + 0 = 161.36 Te

Pc = 841.90/3 – 2003.72 * 2.8/47.04 – 0 = 161.36 Te

841.90 Te

Axle Line Loads At Point:

| | | | |
|---|---|---|---|
| A = 519.17 Te/24 axle lines + 104 Te wt. of the trailer/24 lines = | 25.96 Te | < | 34 Te Allowable |
| B = 161.36/12 + 64/12 = | 18.78 Te | < | 34 Te |
| C = | 18.78 Te | < | 34 Te |

COMMENTS:

1. The load on the trailer shown in the TRAILER DATA for FIELD 2 & 3 of 135.5 Te is for each field.
2. The axle loadings in field 1 as calculated above are not quite the same as those listed in the table. But, due to the fact that some dimensions used might have been a little different when calculating the table and in the calculations above, it is reasonable and close enough for bridge work. And it is well below the allowable. The same comment for fields 2 & 3.
3. Notice that Iy & My are zero in the calculations as the CG was on the longitudinal centerline.
4. It is left to the reader to verify the values in the TRAILER DATA table for the upper turning point.

FLUOR

CALCULATIONS and SKETCHES

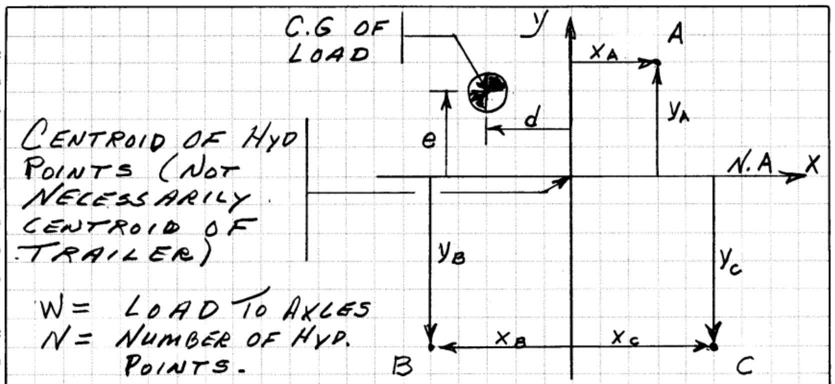
DATE 3-29-83

CONT. NO.

BY K.E. GOODMAN CHK'D

SHEET NO. 1 OF 1

AXLE LOADS WHEN THE CG OF LOAD IS NOT ON THE ℄ TRAILER




W = LOAD TO AXLES

N = NUMBER OF HYD. POINTS.

FLEXURE FORMULA

$$f = \frac{P}{A} \pm \frac{Mc}{I}$$

$$= \frac{P}{N} \pm \frac{M_x\, y_{(i)}}{I_x} \pm \frac{M_y\, x_{(i)}}{I_y}$$

WHERE

$I_x = y_A^2 + y_B^2 + y_c^2$

$I_y = x_A^2 + x_B^2 + x_c^2$

$M_x = We$

$M_y = Wd$

$P_A = W/3 + We\, y_A/I_x - Wd\, x_A/I_y$

$P_B = W/3 - We\, y_B/I_x + Wd\, x_B/I_y$

$P_C = W/3 - We\, y_c/I_x - Wd\, x_c/I_y$

PRINTED IN U.S.A.

As a side note, the GBP is calculated by dividing the load by the shadow area of the trailer. Most European heavy lift companies use a shadow area that includes the GBP going down at a 45° angle to a depth of 0.5 m below the top of the lift pad. This angle starts at the edge of the trailer. In effect, this adds 0.5 m of shadow area to each side and to each end of the trailer.

This photo shows the vessel set on the foundation.

Another photo of the vessel set on the foundation.  Sorry about the photo being out of level.  The photographer who took this series of photos didn't take the time or didn't have a sense of making sure things were plumb.

This photo shows the ringer crane ready to be jacked up so the SPMT's can be placed under it for moving to the next heavy lift pad.  There really isn't any comparison for moving this crane by tearing it down vs. using the SPMT's.

1. The SPMT's are already on site, therefore there would be no extra move in expense
2. The cost of dis-assembling/assembling the crane would be in the neighborhood of $500,000
3. The area would be tied up at the old lift site and the new lift site for at least two to three weeks each, which is costly for the units and causes a lot of non-production/interference time for their crews
4. And the list goes on

The ringer crane on the move & fully rigged up.

Still moving.

A closer look at the ringer and the trailers.

A close up look that shows 6 lines of SPMT's carrying the front of the crane, ie, the boom fully rigged and half of the ring.

Also note the location of the two boom foot carriers and how much length they cover on the ring.  Again, spreading out the load to the ring from the twin booms.

I couldn't find any drawings or data on the configuration of the trailers transporting the ringer crane.

This photo shows two lines of SPMT's carrying the back part of the ring and the remaining counterweight. Note that only enough counterweight was left on the ring to balance the boom, hook, etc.

# COMMENTS:

ON THE LIFT:

1. The assembly of the ringer crane started on the 3rd of October 1998
2. The assembly of the ringer crane was completed on the 17th of October
3. The long radius load test was made on the 18th of October
4. 2C-1504B was set on the 25th of October. Other lifts were made before 2C-1504B
   - Lift started at 6:30 am
   - Vessel upended at 9:30 am
   - Lift completed at 11:30 am

ON TRANSPORTING THE RINGER CRANE WITH THE SPMT's:

1. Started tearing down the ringer crane on the 31st of October
2. Moved the ringer crane in the early morning on the 2nd of November

ON SETTING UP THE RINGER CRANE:

1. Started setting up the ringer in the afternoon of the 2nd of November
2. Ready to lift in the afternoon on the 4th of November

**END OF PRESENTATION:**