KONTRAKT RAPPORT

NVE GRASDALEN

SNØFORSKNING

INSTRUMENTERING AV MAST

75420-1 10.januar 1977

20/4-77

Kontrakt Rapport

NVE GRASDALEN

SNØFORSKNING

INSTRUMENTERING AV MAST

75420-1 10. JANUAR 1977

DENNE RAPPORT INNEHOLDER EN KORT INSTRUMENTERINGSBESKRIVELSE AV 2 STK. MASTEBEN (U260) VERTIKALTSTÅENDE, OG 1 STK. HORISONTALTLIGGENDE (U180) PROFIL I GRASDALEN.

SOM BILAG I FØLGER TEGNINGER AV MASTA VED MÅLERPLASSERING. BILAG II SUMMERER AVLESTE DATA OMREGNET TIL SPENNINGER OG MOMENTER VINTEREN 1975/76.

for NORGES GEOTEKNISKE INSTITUTT

Elmo DiBiagio

Elmo DiBiagio

Leif Egil Johansen

Norges geotekniske institutt NGI

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Postboks 40 Tåsen Oslo 8	Sognsveien 72	GEOTEKNIKK	(02) 23 03 88	19787 ngi n

20/4-77

75420-1 datert 10.01.77

INNHOLD

20/4-77

1. PARAMETRE SOM SKAL MÅLES

Opptredende spenninger og momenter i U260 og U180 profilene som følge av snølasta.

2. FORMÅL MED MÅLINGENE

Iaktta snøbelastningens virkningsgrad på mastkonstruksjonen, slik at observerte data for fremtiden kan gi et sikrere dimensjoneringsgrunnlag for slike utsatte konstruksjonselementer.

3. INSTRUMENTERINGSBESKRIVELSE

U260 og U180 profilene til masta ble instrumentert på NGI lager, Ullevål, og fraktet opp til Grasdalen sommeren 1975. Boltene som spenner fast målerne til stålprofilene er skrudd fast etter forutgående oppboring og gjenging. Deretter ble frekvensene innstilt etter aktuelt måleområde. Østvendte måler fikk en $f_o \approx 1550$ Hz. Vestvendte måler $f_o \approx 1000$ Hz. Dessverre ble dette ombyttet under montering av masten, slik at de vestvendte ble innstilt på 1550 Hz og de østvendte 1000 Hz. Dette resulterte i at endel målere falt ut i løpet av vinteren, fordi frekvensen p.g.a. snøbelastningen enten sank eller steg over måleområdet (900 - 2100 Hz). De horisontale P-200 målerne på U180 bjelkene fikk en f_o på ≈ 1250 Hz. Høsten 1976 dro NGI til Grasdalen og monterte ytterligere 7 stk. P-200 målere på masta. 3 stk. ble montert i krysset på vestsiden av mastkonstruksjonen og 2 stk. i hvert strekkstag. F_o for krysset ≈ 1250 Hz, og f_o for strekkstagene ≈ 1000 Hz. Monteringsboltene for disse 7 målere ble skutt inn i profilene ved hjelp av en boltepistol og målerne skrudd fast til disse. Videre avlesninger vil bli foretatt utover vinteren 1976/77.

Skj.nr. 036. 9-76. 5000. Reclamo

20/4-77

4. KABELSPESIFIKASJONER OG MÅLERTYPE

Fra målerne går det en 2- og en 4-par PPOP kabel til et kontrollmodul. Alle målerne på krysset og på de vertikale U-profilene er koblet til kontroll-modulen ved en 2 pars PPOP kabel. Målerne i de horisontale U180 profilene er koblet til kontroll-modulen ved hjelp av en 4 pars PPOP kabel.

Alle monterte målere er av P-200 typen, 1-strengs, Geonor.

LEJ/ag

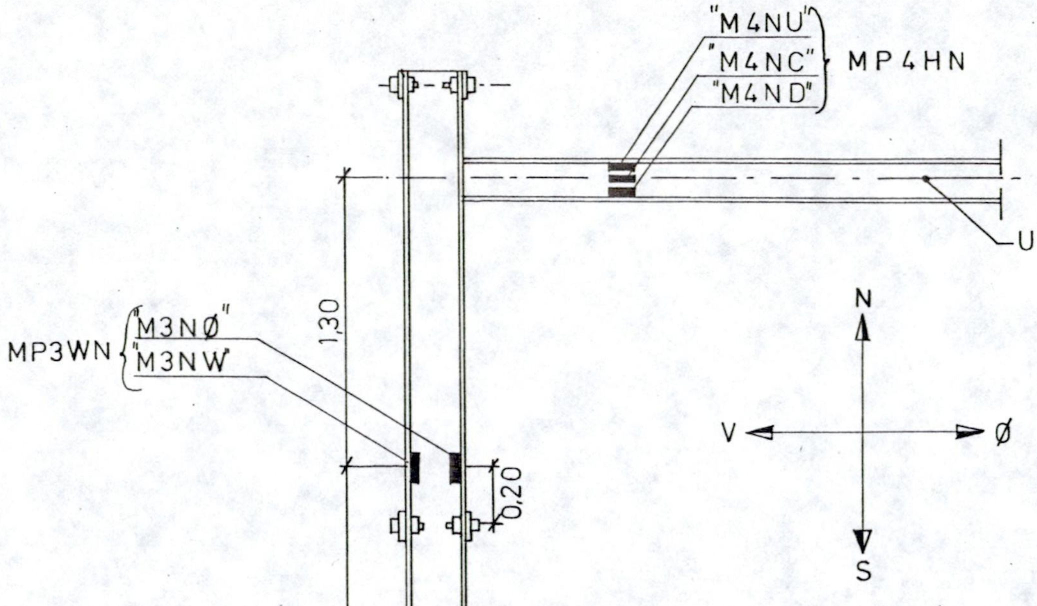
Skj.nr. 036. 9-76. 5000. Reclamo

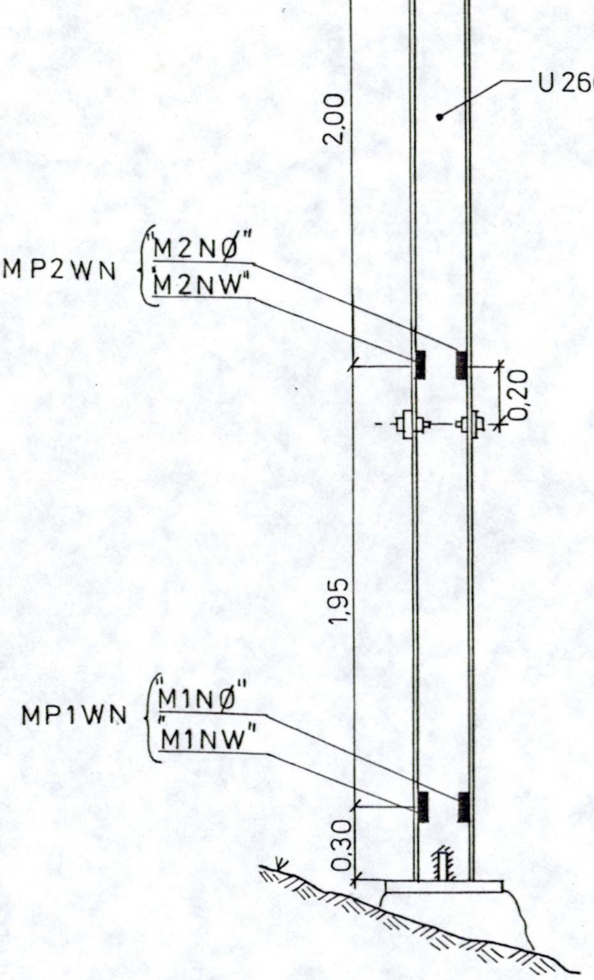
20/5-77

75420-1 datert 10.01.77

5. BILAG I

Tegninger av masta (nr. 1 - 5 inkl.)

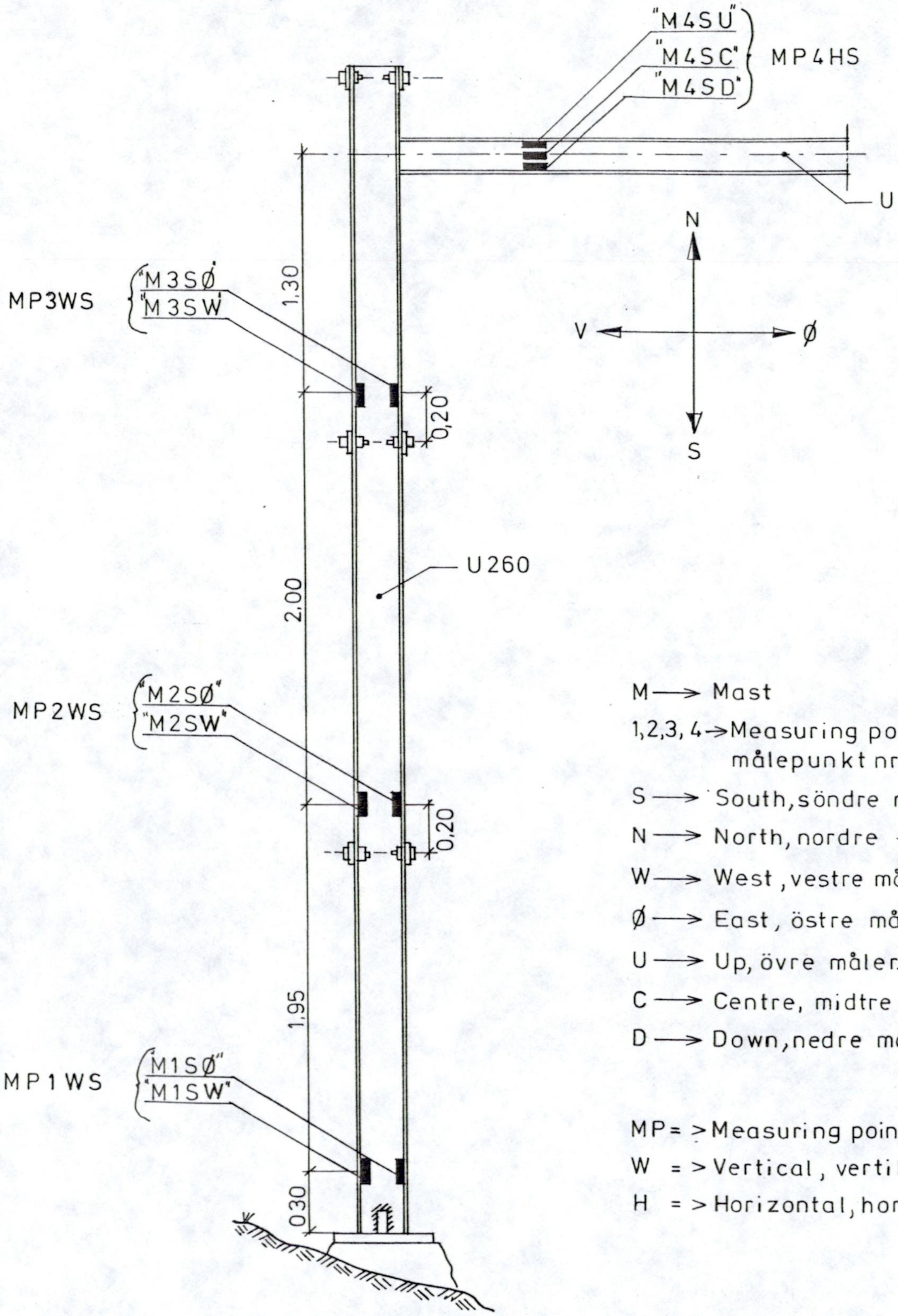




M ⟶ Mast.
1, 2, 3 ⟶ Measuring point no., målepunkt nr.
S ⟶ South, søndre masteben.
N ⟶ North, nordre ——"——
W ⟶ West, vestre måler.
Ø ⟶ East, østre måler.
U ⟶ Up, øvre måler.
C ⟶ Centre, midtre måler.
D ⟶ Down, nedre måler.

MP= > Measuring point, målepunkt.
V= > Vertical, vertikalt
H= > Horizontal, horisontalt

NVE GRASDALEN	Dato 10.3.77 / Tegner [signature]
Instrumentering av mast Nordre masteben.	Godkjent
	Oppdr. nr. 75420
Norges geotekniske institutt	Tegn. nr. 1

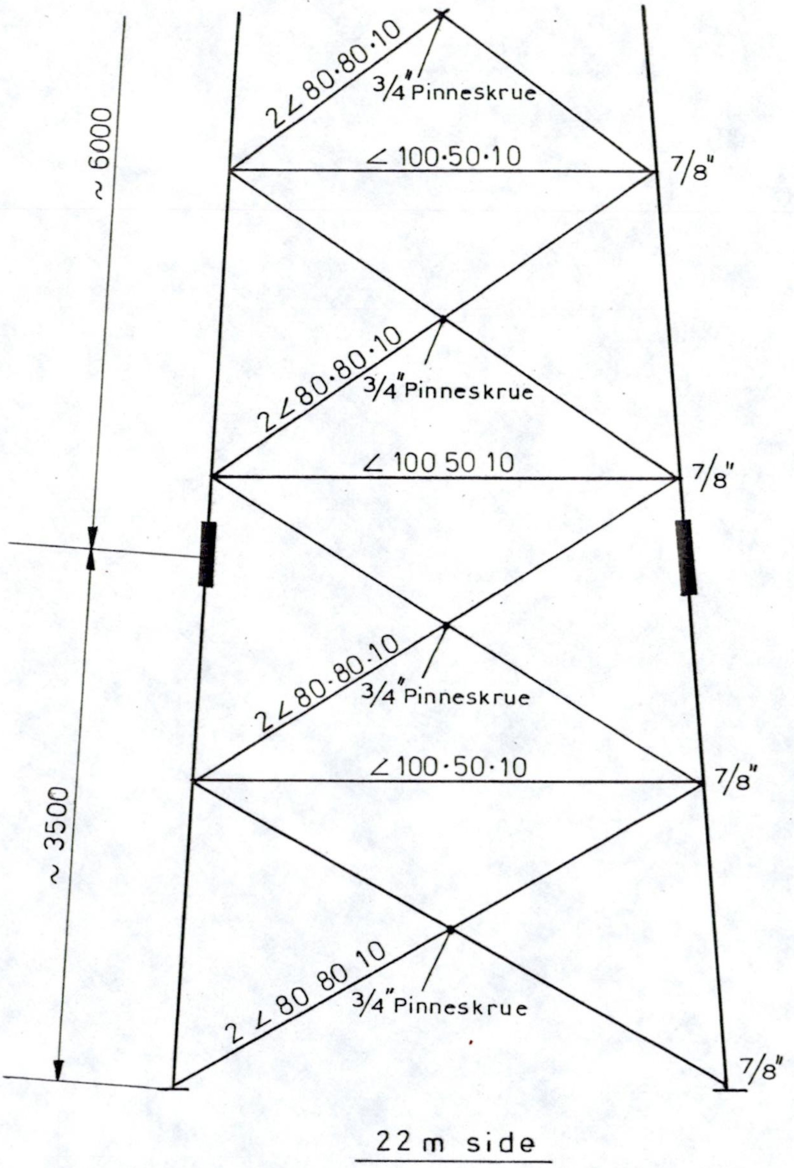


M ⟶ Mast
1,2,3, 4 ⟶ Measuring point no., målepunkt nr.
S ⟶ South, söndre masteben.
N ⟶ North, nordre ——"——
W ⟶ West, vestre måler.
Ø ⟶ East, östre måler.
U ⟶ Up, övre måler.
C ⟶ Centre, midtre måler.
D ⟶ Down, nedre måler.

MP = > Measuring point, målepunkt.
W = > Vertical, vertikalt.
H = > Horizontal, horisontalt

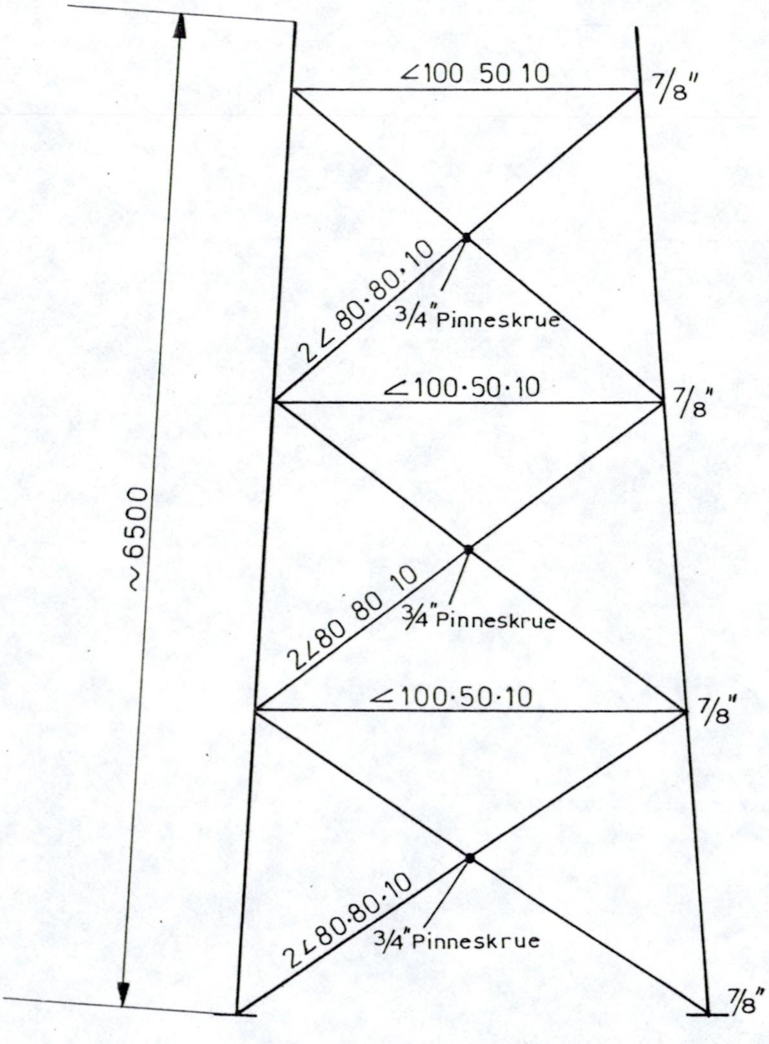
NVE GRASDALEN	Dato 11. 3. 77	Tegner [signature].
Instrumentering av mast. Söndre masteben.	Godkjent	
	Oppdr. nr. 75420	
Norges geotekniske institutt	Tegn. nr. 2	

Skj. nr. 001. 4000. Apr. 76. LOBO.



NVE GRASDALEN	Dato 11. 3. 77	Tegner
Instrumentering av mast.	Godkjent	
	Oppdr. nr. 75420	
Norges geotekniske institutt	Tegn. nr. 3	

Skj. nr. 001. 4000. Apr. 76. LOBO.



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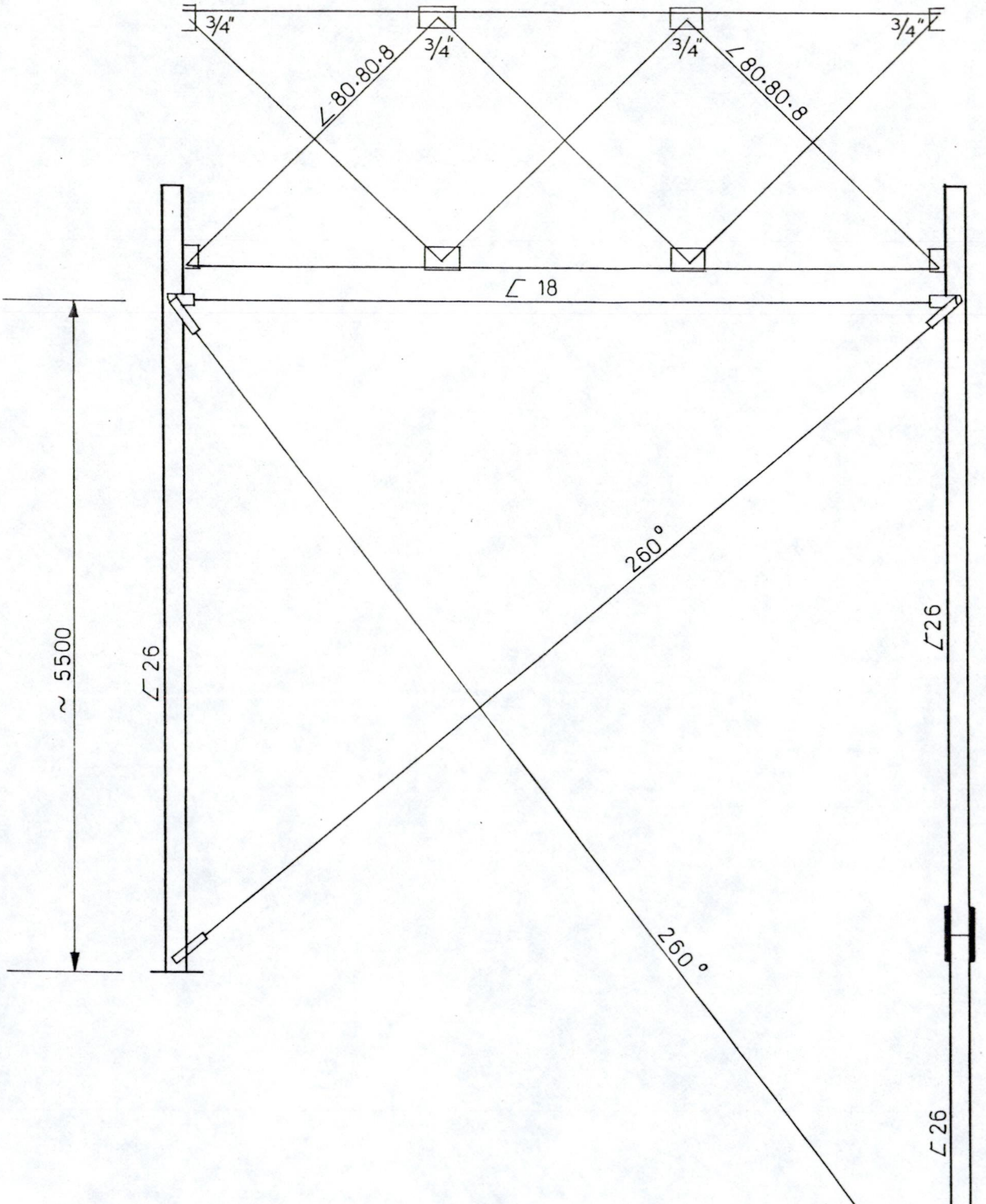
NVE GRASDALEN	Dato 11. 3. 77 / Tegner GR.
Instrumentering av mast.	Godkjent
	Oppdr. nr. 75420
Norges geotekniske institutt	Tegn. nr. 4

Skj. nr. 001. 4000. Apr. 76. LOBO.



NVE GRASDALEN	Dato 11. 3. 77	Tegner GR.
Instrumentering av mast.	Godkjent	
	Oppdr. nr. 75420	
Norges geotekniske institutt	Tegn. nr. 5	

20/4. 77

6. BILAG II

Avleste frekvenser i Hz for P-200 målerne samt verdier omregnet til spenninger, krefter og momenter.

Tabell 1:	Avleste frekvenser i Hz for alle målerne.
Tabell 2:	Utregnede spenninger i Kp/cm^2 for målerne på sydlige masteben.
Tabell 3:	Utregnede spenninger i Kp/cm^2 for målerne på nordlige masteben.
Tabell 4:	Utregnede krefter og momenter for sydlige masteben.
Tabell 5:	Utregnede krefter og momenter for nordlige masteben.

MERK! Skjærkreftene er ikke utregnet p.g.a. usikkerhet med hensyn til grensebetingelsene for mastebenene, og er i tabellene satt lik 0.

Ref. til tegn. nr. 1 og 2 Bilag I for nummerering av målepunktene.

20/4-77

NORWEGIAN GEOTECHNICAL INSTITUTE

FIELD DATA
PROJECT NO. 75420 -MAST-

RESEARCH PROGRAM ON SNOW LOADING

INSTRUMENT DATA
GAUGE TYPE: GEONOR P-200
CALIB. FACTOR = 1.09 KP/SQ.CM./HZ2/1000

MEASURED FREQUENCIES IN HZ.

DATE	M1SV	M1SØ	M2SV	M2SØ	M3SV	M3SØ	M1NV	M1NØ	M2NV	M2NØ	M3NV	M3NØ	M4SU	M4SC	M4SD	M4NU	M4NC	M4ND
750917	962.	1553.	1000.	1546.	952.	1547.	1098.	1453.	1062.	1600.	1087.	1514.	1279.	1212.	1284.	1216.	1178.	1420.
751018	963.	1553.	1000.	1546.	952.	1547.	1098.	1453.	1062.	1600.	1087.	1514.	1279.	1212.	1284.	1216.	1178.	1420.
751104	963.	1538.	983.	1532.	938.	1538.	1072.	1443.	1025.	1578.	1053.	1495.	1276.	1207.	1278.	1192.	1159.	1394.
751106	956.	1536.	977.	1527.	933.	1535.	1068.	1441.	1021.	1575.	1050.	1493.	1274.	1205.	1275.	1188.	1156.	1393.
751204	957.	1538.	*****	1528.	931.	1535.	1068.	1438.	1018.	1575.	1045.	1491.	1269.	1203.	1270.	1183.	1153.	1388.
760106	562.	1720.	*****	1794.	521.	*****	670.	1660.	*****	1789.	651.	1562.	1158.	1105.	989.	931.	1028.	1228.
760121	*****	1792.	*****	1857.	620.	1673.	538.	1709.	*****	1842.	578.	1596.	1162.	1075.	849.	759.	935.	1240.
760202	*****	1810.	*****	1869.	*****	1679.	490.	1727.	*****	1849.	617.	1607.	1157.	1060.	889.	789.	993.	1235.
760219	*****	1812.	*****	1868.	*****	1680.	478.	1737.	*****	1849.	645.	1610.	1149.	1048.	823.	728.	974.	1230.
760229	*****	1815.	*****	1884.	*****	1706.	453.	1754.	*****	1860.	715.	1632.	1159.	1047.	801.	696.	971.	1239.
760310	*****	1822.	*****	1912.	*****	1740.	414.	1785.	*****	1888.	*****	1662.	1152.	1023.	748.	633.	953.	1246.
760331	*****	1820.	*****	1921.	*****	1762.	387.	1800.	*****	1898.	*****	1697.	1164.	1020.	755.	571.	960.	1250.
760414	*****	1822.	*****	1943.	*****	*****	367.	1829.	*****	1924.	*****	1717.	1149.	1017.	795.	547.	948.	1249.
760430	*****	1819.	*****	1946.	*****	*****	358.	1863.	*****	1941.	*****	1728.	1116.	1018.	887.	516.	927.	1231.
760518	*****	1887.	*****	1996.	*****	*****	*****	1982.	*****	1922.	*****	*****	1117.	1061.	726.	553.	939.	1266.
760526	*****	1816.	*****	1851.	543.	1690.	429.	2008.	*****	1888.	581.	1613.	1112.	1097.	943.	819.	971.	1146.

Bilag I

20/4-77

FIELD DATA
PROJECT NO. 75420 -MAST-

NORWEGIAN GEOTECHNICAL INSTITUTE

RESEARCH PROGRAM ON SNOW LOADING

INSTRUMENT DATA
GAUGE TYPE: GEONOR P-200
CALIB. FACTOR = 1.09 KP/SQ.CM./HZ2/1000

SOUTH STANCHION

CALCULATED STRESSES IN KP/SQ.CM.:-

DATE	M1SV	M1SØ	M2SV	M2SØ	M3SV	M3SØ	M4SU	M4SC	M4SD
750917	0.	0.	0.	0.	0.	0.	0.	0.	0.
751018	2.	0.	0.	0.	0.	0.	0.	0.	0.
751104	2.	-51.	-37.	-47.	-29.	-30.	-8.	-13.	-17.
751106	-13.	-57.	-50.	-64.	-39.	-40.	-14.	-18.	-25.
751204	-10.	-51.	60.	-60.	-43.	-40.	-28.	-24.	-39.
760106	-664.	596.	-903.	903.	-692.	692.	-321.	-270.	-731.
760121	-871.	871.	-1154.	1154.	-569.	442.	-311.	-342.	-1011.
760202	-942.	942.	-1202.	1202.	-464.	464.	-324.	-376.	-936.
760219	-950.	950.	-1198.	1198.	-468.	468.	-344.	-404.	-1059.
760229	-962.	962.	-1264.	1264.	-564.	564.	-319.	-406.	-1098.
760310	-990.	990.	-1380.	1380.	-691.	691.	-337.	-460.	-1187.
760331	-982.	982.	-1417.	1417.	-775.	775.	-306.	-467.	-1176.
760414	-990.	990.	-1510.	1510.	******	******	-344.	-474.	-1108.
760430	-978.	978.	-1523.	1523.	******	******	-426.	-472.	-939.
760518	-1252.	1252.	-1737.	1737.	******	******	-423.	-374.	-1223.
760526	-966.	966.	-1129.	1129.	-666.	505.	-435.	-289.	-828.

Bilag II

20/4.77

NORWEGIAN GEOTECHNICAL INSTITUTE

FIELD DATA
PROJECT NO. 75420 -MAST-

RESEARCH PROGRAM ON SNOW LOADING

INSTRUMENT DATA
GAUGE TYPE: GEONOR P-200
CALIB. FACTOR = 1.09 KP/SQ.CM./HZ2/1000

NORTH STANCHION

CALCULATED STRESSES IN KP/SQ.CM.:-

DATE	M1NV	M1NØ	M2NV	M2NØ	M3NV	M3NØ	4NU	M4NC	M4ND
750917	0.	0.	0.	0.	0.	0.	0.	0.	0.
751018	0.	0.	0.	0.	0.	0.	0.	0.	0.
751104	-61.	-32.	-84.	-76.	-79.	-62.	-63.	-48.	-80.
751106	-71.	-38.	-93.	-87.	-86.	-69.	-73.	-56.	-83.
751204	-71.	-47.	-100.	-87.	-98.	-75.	-86.	-64.	-98.
760106	-825.	702.	-698.	698.	-826.	161.	-667.	-361.	-554.
760121	-999.	882.	-908.	908.	-924.	278.	-984.	-560.	-522.
760202	-1052.	950.	-936.	936.	-873.	316.	-933.	-438.	-535.
760219	-1065.	987.	-936.	936.	-834.	327.	-1034.	-479.	-549.
760229	-1090.	1052.	-981.	981.	-731.	405.	-1084.	-485.	-525.
760310	-1127.	1172.	-1095.	1095.	-512.	512.	-1175.	-523.	-506.
760331	-1151.	1230.	-1136.	1136.	-640.	640.	-1256.	-508.	-495.
760414	-1167.	1345.	-1245.	1245.	-715.	715.	-1286.	-533.	-497.
760430	-1174.	1482.	-1316.	1316.	-756.	756.	-1322.	-576.	-546.
760518	-1981.	1981.	-1236.	1236.	******	******	-1278.	-551.	-451.
760526	-1114.	2094.	-1095.	1095.	-920.	337.	-881.	-485.	-766.

Bilag III

20/4-77

NORWEGIAN GEOTECHNICAL INSTITUTE

FIELD DATA
PROJECT NO. 75420 -MAST-

RESEARCH PROGRAM ON SNOW LOADING

INSTRUMENT DATA
GAUGE TYPE: GEONOR P-200
CALIB. FACTOR = 1.09 KP/SQ.CM./HZ2/1000

BENDING MOMENTS,AXIAL FORCES AND SHEAR FORCES IN VERTICAL U26 AND HORIZONTAL U18

SOUTH STANCHION

	**********MP1VS********			**********MP2VS********			**********MP3VS********			**********MP4HS********		
DATE	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)
750917	0.	.00	.00	0.	.00	.00	0.	.00	.00	0.	.00	.00
751018	-4.	.05	.00	0.	.00	.00	0.	.00	.00	0.	.00	.00
751104	-112.	-1.17	.00	-22.	-2.02	.00	-3.	-1.43	.00	-7.	-.36	.00
751106	-95.	-1.69	.00	-30.	-2.73	.00	-3.	-1.92	.00	-10.	-.54	.00
751204	-86.	-1.47	.00	-257.	.00	.00	6.	-2.01	.00	-10.	-.84	.00
760106	2689.	-1.66	.00	3854.	.00	.00	2954.	.00	.00	-359.	-12.34	.00
760121	3719.	.00	.00	4924.	.00	.00	2158.	-3.06	.00	-614.	-15.53	.00
760202	4021.	.00	.00	5132.	.00	.00	1981.	.00	.00	-536.	-15.27	.00
760219	4055.	.00	.00	5114.	.00	.00	1997.	.00	.00	-627.	-16.86	.00
760229	4105.	.00	.00	5394.	.00	.00	2406.	.00	.00	-683.	-17.01	.00
760310	4224.	.00	.00	5888.	.00	.00	2951.	.00	.00	-746.	-18.52	.00
760331	4190.	.00	.00	6049.	.00	.00	3310.	.00	.00	-762.	-18.19	.00
760414	4224.	.00	.00	6444.	.00	.00	********	******	.00	-670.	-17.98	.00
760430	4173.	.00	.00	6498.	.00	.00	********	******	.00	-451.	-17.14	.00
760518	5345.	.00	.00	7415.	.00	.00	********	******	.00	-701.	-18.85	.00
760526	4122.	.00	.00	4820.	.00	.00	2499.	-3.91	.00	-344.	-14.49	.00

Bilag IV

20/4-77

FIELD DATA
PROJECT NO. 75420 -MAST-

NORWEGIAN GEOTECHNICAL INSTITUTE

RESEARCH PROGRAM ON SNOW LOADING

INSTRUMENT DATA
GAUGE TYPE: GEONOR P-200
CALIB. FACTOR = 1.09 KP/SQ.CM./HZ2/1000

BENDING MOMENTS,AXIAL FORCES AND SHEAR FORCES IN VERTICAL U26 AND HORIZONTAL U18

NORTH STANCHION

	**********MP1VN********			**********MP2VN********			**********MP3VN********			**********MP4HN********		
DATE	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)	BENDING MOMENT (KP*M.)	AXIAL FORCE (T)	SHEAR FORCE (T)
750917	0.	.00	.00	0.	.00	.00	0.	.00	.00	0.	.00	.00
751018	0.	.00	.00	0.	.00	.00	0.	.00	.00	0.	.00	.00
751104	64.	-2.25	.00	17.	-3.87	.00	36.	-3.42	.00	-15.	-1.78	.00
751106	70.	-2.62	.00	14.	-4.34	.00	37.	-3.74	.00	-8.	-1.98	.00
751204	50.	-2.85	.00	28.	-4.50	.00	48.	-4.18	.00	-10.	-2.31	.00
760106	3259.	-2.96	.00	2980.	.00	.00	2106.	-16.06	.00	99.	-14.76	.00
760121	4014.	-2.81	.00	3875.	.00	.00	2565.	-15.60	.00	405.	-19.28	.00
760202	4273.	-2.48	.00	3995.	.00	.00	2538.	-13.44	.00	349.	-17.79	.00
760219	4380.	-1.87	.00	3995.	.00	.00	2478.	-12.26	.00	425.	-19.24	.00
760229	4572.	-.92	.00	4185.	.00	.00	2423.	-7.87	.00	490.	-19.54	.00
760310	4906.	1.07	.00	4673.	.00	.00	2187.	.00	.00	587.	-20.56	.00
760331	5082.	1.92	.00	4850.	.00	.00	2734.	.00	.00	668.	-21.09	.00
760414	5362.	4.29	.00	5312.	.00	.00	3051.	.00	.00	691.	-21.62	.00
760430	5669.	7.43	.00	5618.	.00	.00	3228.	.00	.00	680.	-22.81	.00
760518	8454.	.00	.00	5276.	.00	.00	********	******	.00	725.	-21.29	.00
760526	6844.	23.67	.00	4673.	.00	.00	2683.	-14.07	.00	100.	-19.90	.00

EFIN NGSBH

Bilag V

20/4-77

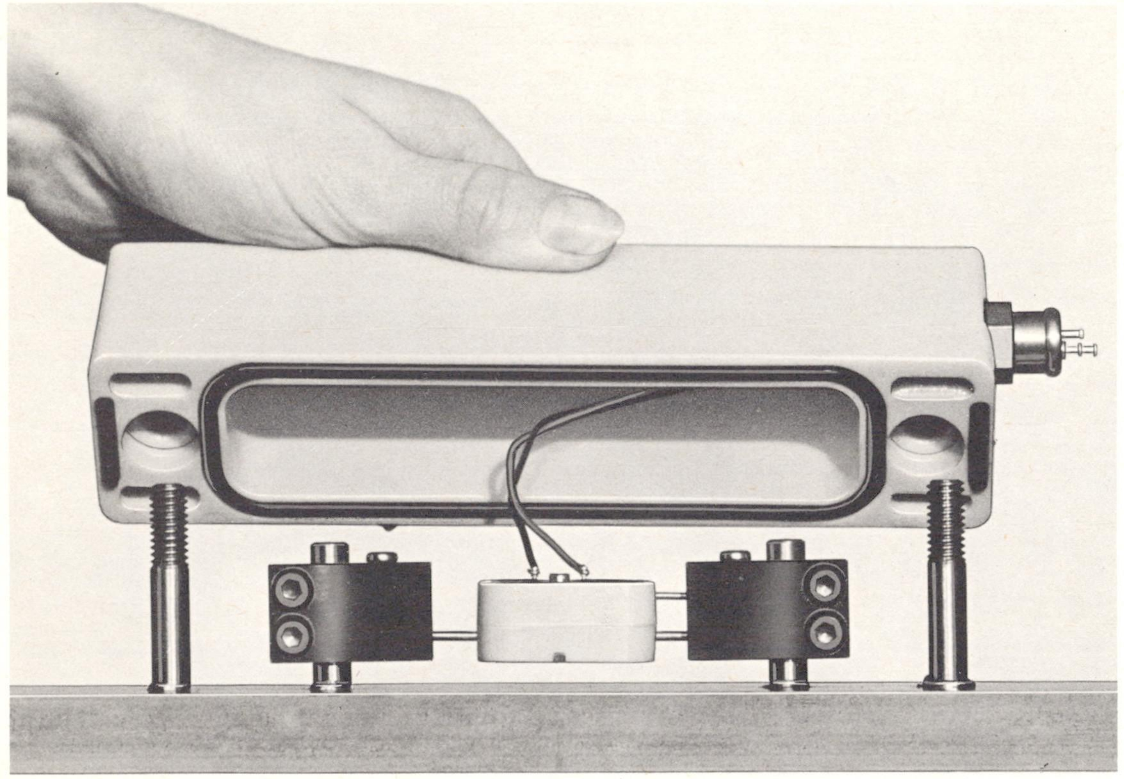
75420-1 datert 10.01.77

7. BILAG III

Beskrivelse av P-200 måleren.

20/4-77

P-200-220 VIBRATING-WIRE STRAIN GAUGE



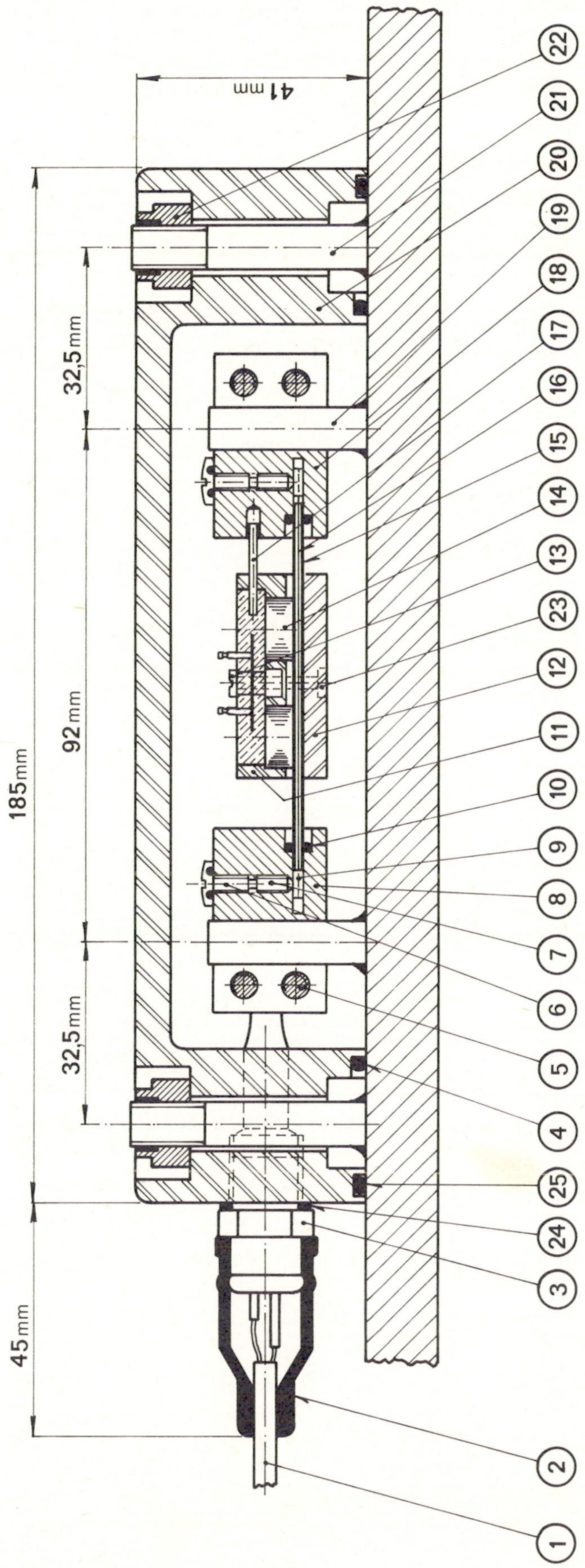
USES

The Preassembled and Sealed Vibrating-Wire Strain Gauge is a surface mounting gauge that is used to measure strains or stresses in any structural element to which it can be mounted. The gauge is fastened directly to two support posts which have been previously attached to the structural element. The support posts can be set in drilled and tapped holes; they can be mounted by a stud-welding process or they can be cast in concrete members. The gauge can be used under water. The housing is highly resistant to impact. Since the measurements can be taken far away from the gauge itself, the use of the gauge does not cause inconvenience to construction.

FEATURES:

- Convenient, accurate, sensitive, and stable.
- Rugged construction and waterproof.
- Quick and simple installation.
- Remote and fast measurement.
- Easy maintenance and repair.

GEONOR A/S
P.O. BOX 99 - RØA - OSLO 7 - NORWAY - TELEGRAM ADDRESS: GEONOR - OSLO



DESCRIPTION

A complete GEONOR Vibrating-Wire Strain Gauge consists of two preassembled components: the P-200 vibrating-wire gauge itself and the P-220 protective housing fitted with a sealed electrical cable lead through.

The strain gauge itself consists of all the parts between parts No. 5 and 19 in the illustrated drawing. All of these parts are preassembled. The gauge-wire is inside a stainless steel tube (15) which has an O.D. of 2 mm and is about 1 mm shorter in length than the gauge-wire. The magnet holder assembly (11) and (12) is mounted on the steel tube. A clamping pin (9) is swaged onto each end of the gauge-wire. One end of the gauge-wire is clamped by the setscrew (7) during assembly of the gauge. The other end is clamped during installation of the gauge in the field.

The gauge itself is waterproof. The two O-rings (10) provide a seal around the stainless steel tube and the self-sealing screws (6) prevent leakage through the holes for the setscrews. The protective housing, which is made of plastic, is also waterproof since it is fitted with an O-ring seal in the base and a sealed electrical cable lead through. (The effectiveness of the O-ring seal in the base of the housing will of course depend on the relative roughness of the surface on which the gauge is mounted.)

The electrical connections to the gauge housing can be made in a number of different ways. The standard connection is shown in the assembly drawing. The soldered electrical connections to the gauge housing are made via a two-terminal connector that is screwed into the housing. It can be screwed into the end, side or top of the housing if desired and a 90° elbow connector can be included if specified.

The standard connector is shown on the assembly drawing as part No. 3. The connector consists of a 2-pin lead through. The outer shell is brass and the space between the shell and the terminals is filled with epoxy. One end of the connector is threaded to screw into the housing and an O-ring in the brass shell seals this connection. The other end is normally turned down to a constant diameter to receive a neoprene boot which is filled with a sealant after the electrical connections have been made.

The gauge is connected directly to the GEONOR Read-Out Unit (See special leaflet) or, if desired, indirectly through a switch box. After the electrical connections have been made and the unit is turned on, the gauge-wire will start to vibrate and after a few seconds the vibrations will attain a constant amplitude and the wire will continue to oscillate as long as the unit is turned on. The frequency of vibration of the gauge-wire will be indicated by the digital display in the Read-Out Unit.

Once the change in the square of the frequency of the gauge-wire is known, the corresponding change in stress in the structural member is given by the following theoretical expression which has been verified by extensive laboratory investigations:

$$\Delta\sigma = (\sigma - \sigma_o) = \frac{4L^2\rho}{g} \frac{L}{L_g} \frac{E_m}{E_w} \cdot (f^2 - f_o^2) \cdot 10^{-3}$$

where σ_o = stress in the structure at the frequency f_o
σ = stress in the structure at frequency f
L = length of gauge-wire
L_g = gauge length (center to center of the support posts)
ρ = density of the gauge-wire material
E_w = modulus of elasticity of the gauge-wire
E_m = modulus of elasticity of the structural member
g = acceleration due to gravity
k = a constant depending on the end condition of the gauge-wire, 1.00 for wire with simply supported ends and 1.06 for wire with fixed or clamped ends.

For a given design of the strain gauge and for an installation on a particular structural material, the above expression can be simplified as follows:

$$\Delta\sigma = K \cdot (f^2 - f_o^2) \cdot 10^{-3}$$

where K = strain gauge constant depending on the properties of the materials and gauge dimensions.

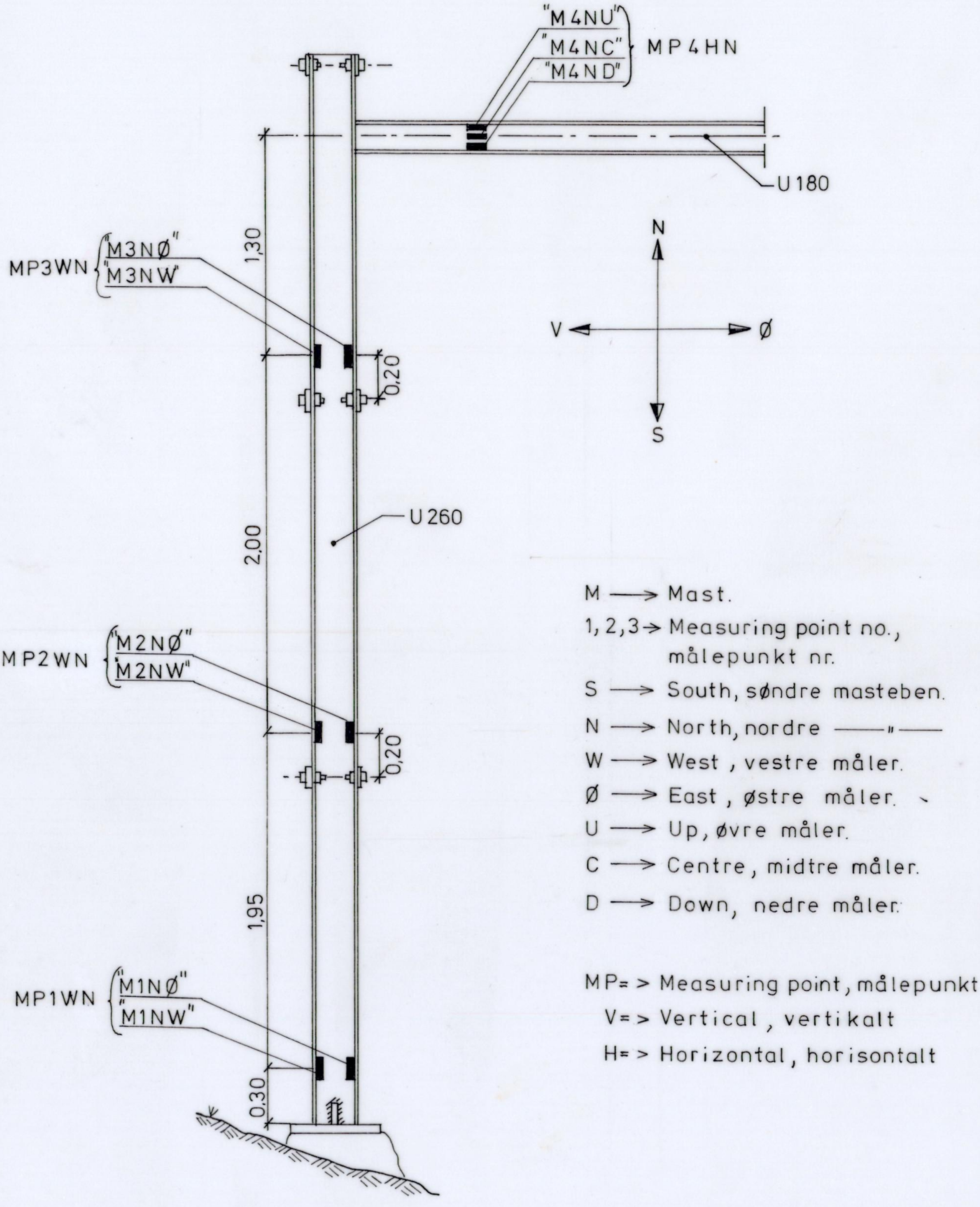
The current GEONOR Vibrating-Wire Strain Gauge is designed such that the distance between the support posts, L_g, is 92 mm center to center and the length of the gauge-wire, L, is 66 mm. The gauge-wire is made of silver plated steel. If the gauge is mounted on a steel member and the frequencies f and f_o are expressed in cycles per second, the strain gauge constant, K, of 1.09 will give the stress change in kg/cm^2 and K of 15.5 will give the stress change in lbs/in^2.

Detailed step-by-step instructions for installation of the GEONOR Vibrating-Wire Strain Gauge are supplied with the instruments.

SPECIFICATIONS:

Recommended operating frequency range 700–1500 c/s.
Accuracy ± 5 %.
Operating temperature − 20° to + 50° C.
Shipping dimensions P-200 155 x 39 x 27 mm; P-220 215 x 47 x 44 mm
Shipping weights P-200 155 grams
P-220 219 grams

A separate information sheet which describes the operating principle of the vibrating-wire instruments is available upon request. Please ask for the General Introduction to the Geonor Vibrating-Wire Instruments.



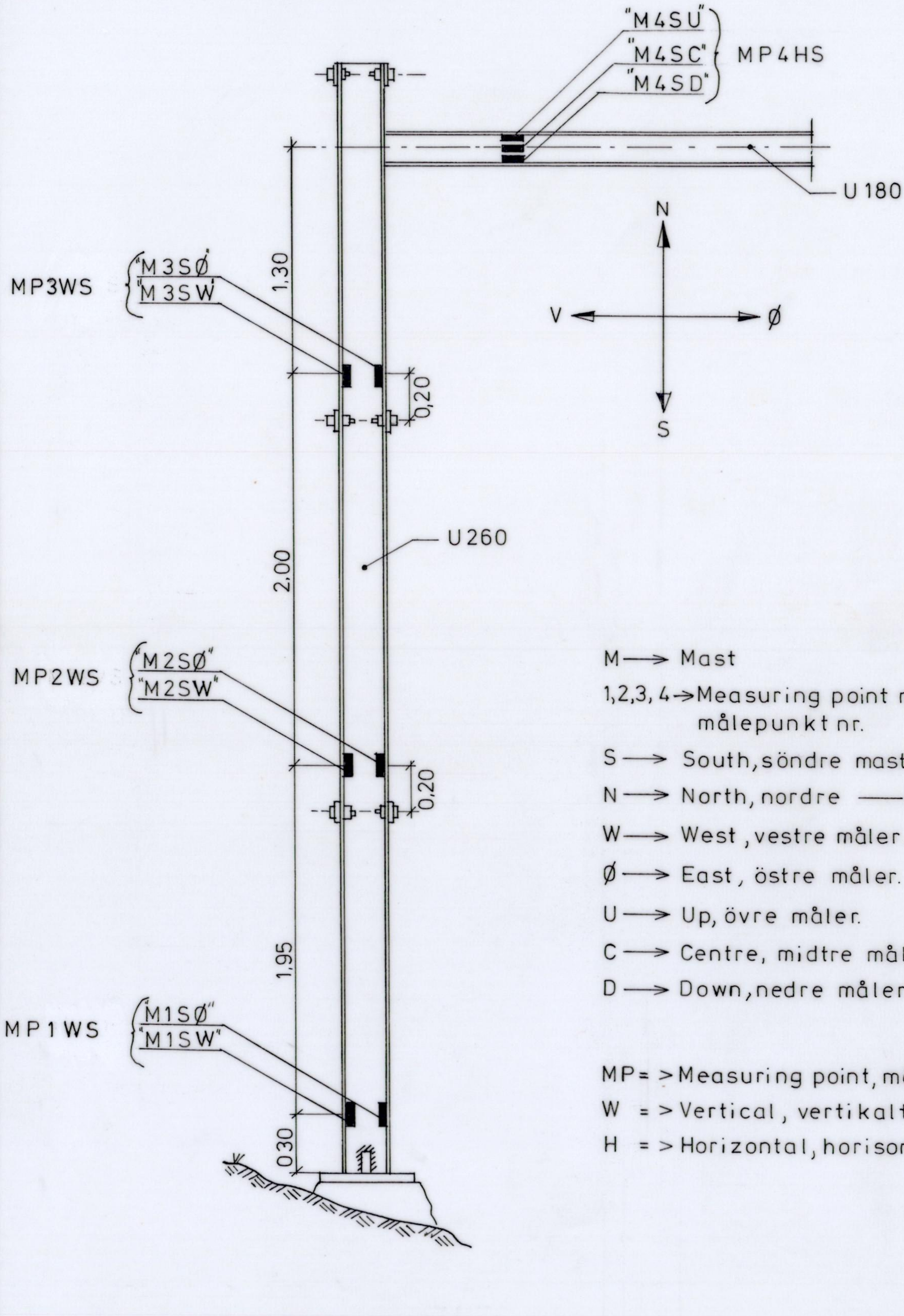
NVE GRASDALEN

Instrumentering av mast
Nordre masteben.

Norges geotekniske institutt

Dato 10.3.77	Tegner [signature]
Godkjent	
Oppdr. nr. 75420	
Tegn. nr. 1	

Skj. nr. 001. 4000. Apr. 76. LOBO.



M ⟶ Mast

1,2,3, 4 ⟶ Measuring point no., målepunkt nr.

S ⟶ South, söndre masteben.

N ⟶ North, nordre ——"——

W ⟶ West, vestre måler.

Ø ⟶ East, östre måler.

U ⟶ Up, övre måler.

C ⟶ Centre, midtre måler.

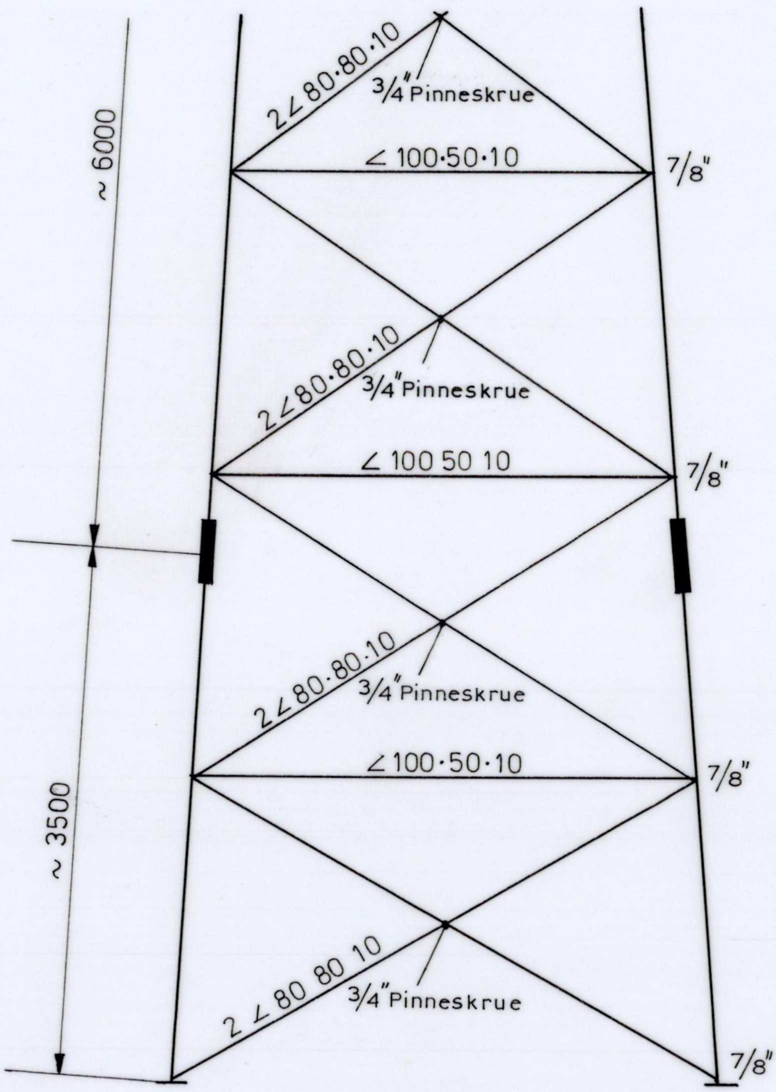
D ⟶ Down, nedre måler.

MP = > Measuring point, målepunkt.

W = > Vertical, vertikalt.

H = > Horizontal, horisontalt

NVE GRASDALEN	Dato 11. 3. 77 — Tegner *[signature]*
Instrumentering av mast. Söndre masteben.	Godkjent
	Oppdr. nr. 75420
Norges geotekniske institutt	Tegn. nr. 2



22 m side

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Instrumentering av mast.	Godkjent	
	Oppdr. nr. 75420	
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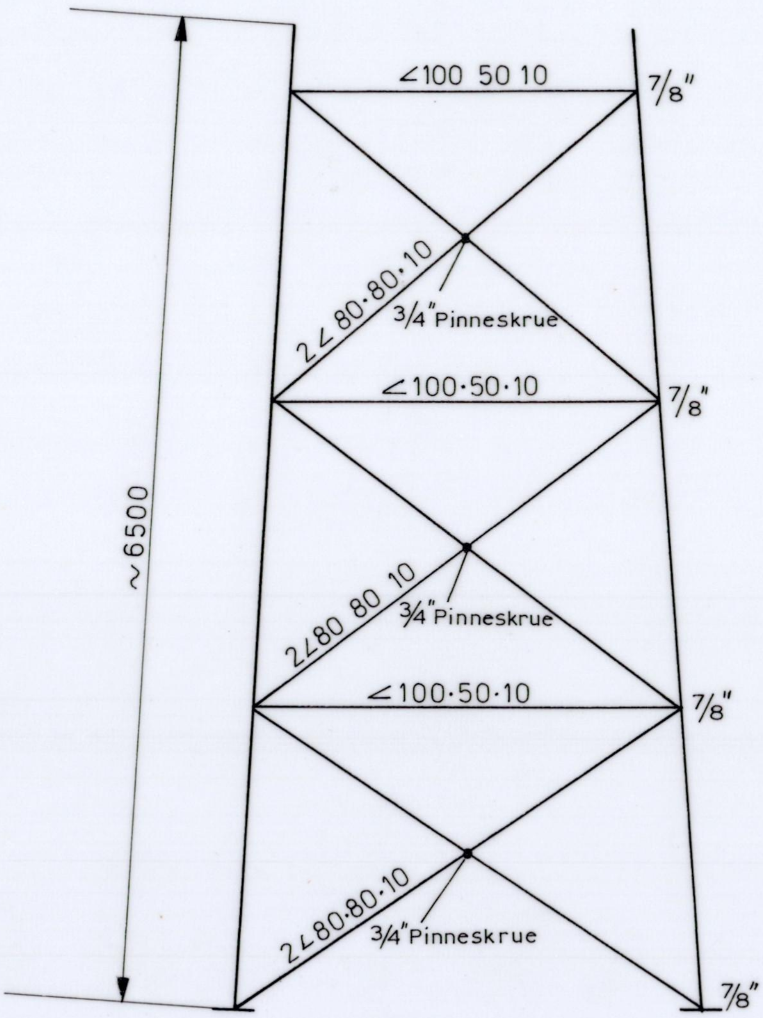

19 m side

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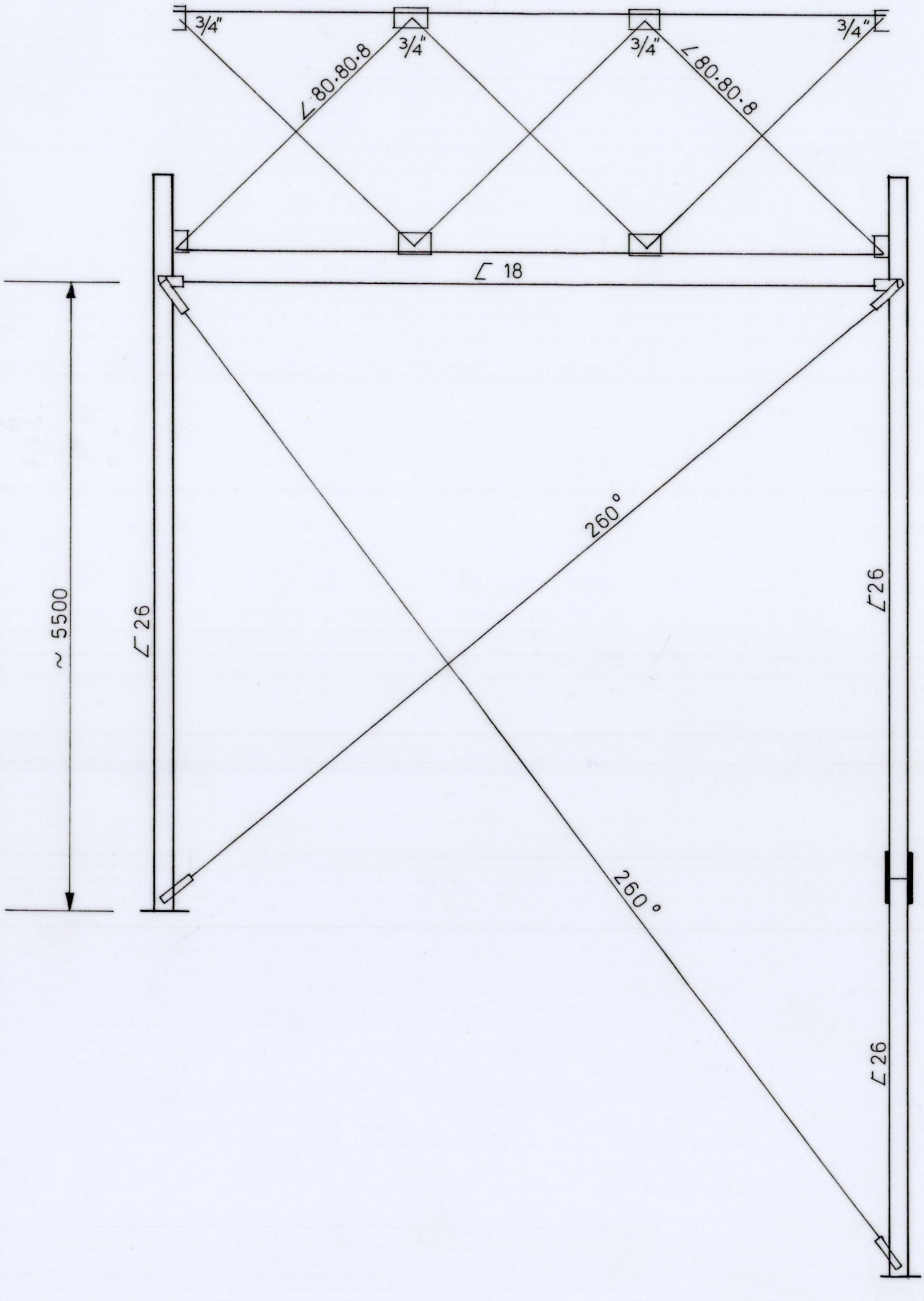
Instrumentering av mast.	Godkjent
	Oppdr. nr. 75420
Norges geotekniske institutt	Tegn. nr. 4



NVE GRASDALEN	Dato 11. 3. 77 / Tegner
Instrumentering av mast.	Godkjent
	Oppdr. nr. 75420
Norges geotekniske institutt	Tegn. nr. 5

Skj. nr. 001. 4000. Apr. 76. LOBO.