

SURAT KETERANGAN TUGAS AKHIR

Sesuai dengan persetujuan dari Ketua Jurusan Teknik Sipil, Fakultas Teknik, Universitas Kristen Maranatha, melalui surat No. 1216/TA/FTS/UKM/VII/2010 tanggal 23 Agustus 2010, dengan ini saya selaku Pembimbing Tugas Akhir memberikan tugas kepada:

Nama : FERRY FANJAYA

NRP : 0721021

untuk membuat Tugas Akhir bidang Struktur dengan judul:

**ANALISIS DAN DESAIN ATAP CANGKANG BETON PRATEGANG
BENTUK *SPHERICAL DOME***

Pokok pembahasan Tugas Akhir adalah sebagai berikut:

1. Pendahuluan
2. Tinjauan Literatur
3. Studi Kasus dan Pembahasan
4. Kesimpulan dan Saran

Hal-hal lain yang dianggap perlu dapat disertakan untuk melengkapi penulisan Tugas Akhir ini.

Bandung, 23 Agustus 2010



Ny. Winarni Hadipratomo, Ir.
Pembimbing

SURAT KETERANGAN SELESAI TUGAS AKHIR

Yang bertanda tangan di bawah ini selaku Dosen Pembimbing Tugas Akhir dari mahasiswa:

Nama : Ferry Fanjaya

NRP : 0721021

menyatakan bahwa Tugas Akhir dari mahasiswa tersebut diatas dengan judul:

**ANALISIS DAN DESAIN ATAP CANGKANG BETON PRATEGANG
BENTUK *SPHERICAL DOME***

dinyatakan selesai dan dapat diajukan pada Ujian Sidang Tugas Akhir (USTA).

Bandung, 3 Januari 2011



Ny. Winarni Hadipratomo, Ir.

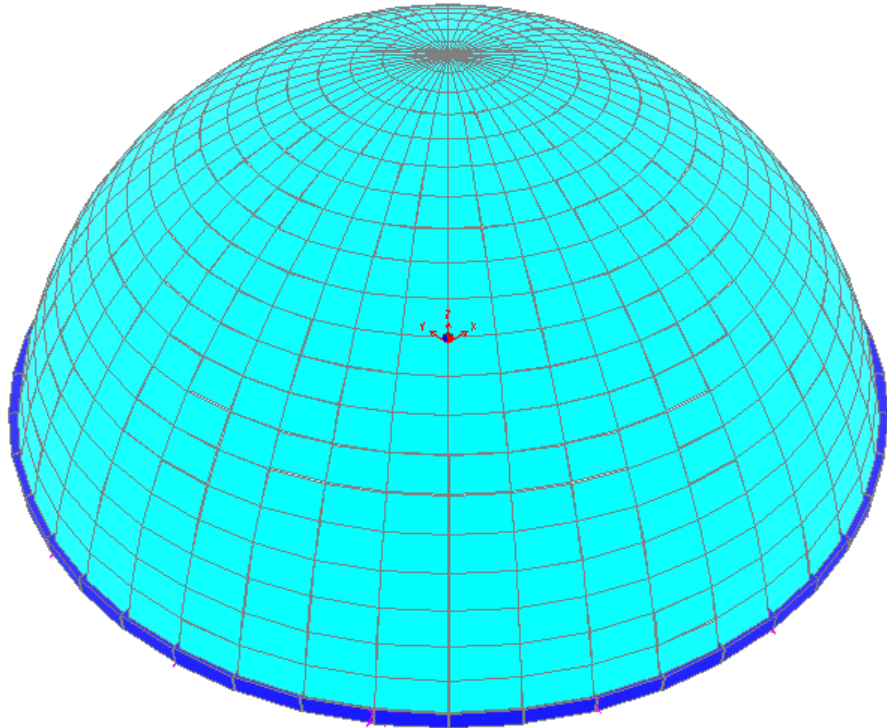
Pembimbing

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- L.4 Gambar Panjang Penyaluran Tulangan Radial**
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- L.6 Manual Dari VSL**
- L.7 Langkah-Langkah Menambahkan Gaya Prategang Tendon**
- L.8 Gambar Perbandingan Struktur Tanpa Tendon Dan Struktur Dengan Tendon.**

LAMPIRAN I

Gambar *Spherical Dome*



Gambar L1 *Spherical Dome*

LAMPIRAN II

Table Element Force-Area Shells

Tabel L2.1 *Table Element Force-Area Shells* Tepi Cangkang Bawah Akibat Kombinasi 1

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 1 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 1 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 2 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 3 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 4 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 5 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 6 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 7 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 8 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 9 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 10 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 11 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 12 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 13 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 14 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 15 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 16 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 17 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 18 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 19 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 20 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 21 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 22 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 23 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 24 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 25 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 26 | COMB1 | -149.63 | -461.13 | -481.13 | 2461.1 |
| 27 | COMB1 | -47.76 | 48.24 | 570.73 | 330.7 |
| 28 | COMB1 | 47.79 | 65.98 | 352.07 | 15.96 |
| 29 | COMB1 | -149.63 | -461.13 | -481.13 | 2461.1 |
| 30 | COMB1 | -47.76 | 48.24 | 570.73 | 330.7 |

Tabel L2.1 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 1 (lanjutan)

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 31 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 32 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 33 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 34 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 35 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 36 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 37 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 38 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 39 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 40 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 41 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 42 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 43 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 44 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 45 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |
| 46 | COMB1 | 47.79 | 65.98 | 1002.96 | -381.68 |
| 47 | COMB1 | -149.63 | -461.13 | -2133.15 | 1458.18 |
| 48 | COMB1 | -47.76 | 48.24 | 1148.34 | -85.64 |

Tabel L2.2 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 2

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 1 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 1 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 2 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 3 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 4 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 5 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 6 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 7 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 8 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 9 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 10 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 11 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 12 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 13 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 14 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 15 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 16 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 17 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 18 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 19 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 20 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 21 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 22 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 23 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 24 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 25 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 26 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 27 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 28 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 29 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 30 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |

Tabel L2.2 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 2 (lanjutan)

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 31 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 32 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 33 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 34 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 35 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 36 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 37 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 38 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 39 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 40 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 41 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 42 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 43 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 44 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 45 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |
| 46 | COMB2 | 53.27 | 69.31 | 988.72 | -509.12 |
| 47 | COMB2 | -158.79 | -497.22 | -2133.66 | 1618.59 |
| 48 | COMB2 | -49.29 | 50.27 | 1135 | -194.69 |

Tabel L2.3 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 3

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 1 | COMB3 | 49.07 | 65.31 | 945.6 | -449.04 |
| 1 | COMB3 | 49.05 | 65.18 | 964.41 | -445.78 |
| 2 | COMB3 | -148.54 | -464.28 | -2048.85 | 1494.05 |
| 3 | COMB3 | -47.81 | 47.25 | 1080.45 | -153.51 |
| 4 | COMB3 | 49.06 | 65.3 | 966.07 | -445.82 |
| 5 | COMB3 | -147.84 | -464.21 | -2057.26 | 1510.54 |
| 6 | COMB3 | -49.36 | 47.03 | 1080.41 | -148.77 |
| 7 | COMB3 | 48.87 | 65.31 | 1002.27 | -449.7 |
| 8 | COMB3 | -148.49 | -466.17 | -2104 | 1462.18 |
| 9 | COMB3 | -48.46 | 47.42 | 1105.82 | -143.17 |
| 10 | COMB3 | 48.95 | 65.45 | 989.2 | -438 |
| 11 | COMB3 | -149.32 | -465.98 | -2096.56 | 1469.83 |
| 12 | COMB3 | -48 | 47.53 | 1110.15 | -143.42 |
| 13 | COMB3 | 48.88 | 65.44 | 982.86 | -438.96 |
| 14 | COMB3 | -149.6 | -465.7 | -2094.36 | 1468.91 |
| 15 | COMB3 | -47.68 | 47.56 | 1114.17 | -143.1 |
| 16 | COMB3 | 48.85 | 65.44 | 978.25 | -439.39 |
| 17 | COMB3 | -149.85 | -465.6 | -2093.4 | 1468.11 |
| 18 | COMB3 | -47.39 | 47.59 | 1118.21 | -142.84 |
| 19 | COMB3 | 48.84 | 65.47 | 974.12 | -439.95 |
| 20 | COMB3 | -150.13 | -465.67 | -2092.98 | 1467.99 |
| 21 | COMB3 | -47.11 | 47.63 | 1122.49 | -142.72 |
| 22 | COMB3 | 48.87 | 65.51 | 970.16 | -440.75 |
| 23 | COMB3 | -150.47 | -465.93 | -2093.16 | 1468.44 |
| 24 | COMB3 | -46.82 | 47.69 | 1127.6 | -142.58 |
| 25 | COMB3 | 48.92 | 65.56 | 965.84 | -442.09 |
| 26 | COMB3 | -150.89 | -466.35 | -2095.21 | 1468.27 |
| 27 | COMB3 | -46.49 | 47.79 | 1132.86 | -141.89 |
| 28 | COMB3 | 48.91 | 65.45 | 964.17 | -442.06 |
| 29 | COMB3 | -151.59 | -466.42 | -2086.81 | 1451.79 |
| 30 | COMB3 | -44.94 | 48.01 | 1132.9 | -146.63 |

Tabel L2.3 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 3 (lanjutan)

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 31 | COMB3 | 49.1 | 65.43 | 927.97 | -438.18 |
| 32 | COMB3 | -150.94 | -464.46 | -2040.06 | 1500.14 |
| 33 | COMB3 | -45.83 | 47.62 | 1107.5 | -152.23 |
| 34 | COMB3 | 49.02 | 65.3 | 941.04 | -449.87 |
| 35 | COMB3 | -150.11 | -464.66 | -2047.51 | 1492.49 |
| 36 | COMB3 | -46.3 | 47.51 | 1103.17 | -151.99 |
| 37 | COMB3 | 49.09 | 65.31 | 947.38 | -448.91 |
| 38 | COMB3 | -149.83 | -464.93 | -2049.71 | 1493.41 |
| 39 | COMB3 | -46.62 | 47.48 | 1099.15 | -152.3 |
| 40 | COMB3 | 49.12 | 65.3 | 951.99 | -448.48 |
| 41 | COMB3 | -149.58 | -465.04 | -2050.66 | 1494.21 |
| 42 | COMB3 | -46.91 | 47.45 | 1095.11 | -152.56 |
| 43 | COMB3 | 49.12 | 65.28 | 956.12 | -447.92 |
| 44 | COMB3 | -149.3 | -464.96 | -2051.08 | 1494.34 |
| 45 | COMB3 | -47.18 | 47.41 | 1090.83 | -152.68 |
| 46 | COMB3 | 49.1 | 65.23 | 960.09 | -447.12 |
| 47 | COMB3 | -148.96 | -464.71 | -2050.9 | 1493.89 |
| 48 | COMB3 | -47.48 | 47.35 | 1085.72 | -152.82 |

Tabel L2.4 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 4

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 1 | COMB4 | 48.23 | 63.75 | 935.06 | -432.72 |
| 1 | COMB4 | 48.26 | 63.88 | 916.25 | -435.98 |
| 2 | COMB4 | -146.14 | -453.68 | -1989.53 | 1466.58 |
| 3 | COMB4 | -44.51 | 46.59 | 1076.52 | -144.9 |
| 4 | COMB4 | 48.25 | 63.76 | 914.58 | -435.94 |
| 5 | COMB4 | -146.84 | -453.75 | -1981.13 | 1450.1 |
| 6 | COMB4 | -42.96 | 46.82 | 1076.56 | -149.64 |
| 7 | COMB4 | 48.44 | 63.75 | 878.39 | -432.06 |
| 8 | COMB4 | -146.19 | -451.8 | -1934.38 | 1498.46 |
| 9 | COMB4 | -43.85 | 46.42 | 1051.15 | -155.24 |
| 10 | COMB4 | 48.36 | 63.61 | 891.46 | -443.76 |
| 11 | COMB4 | -145.36 | -451.99 | -1941.83 | 1490.8 |
| 12 | COMB4 | -44.32 | 46.32 | 1046.82 | -154.99 |
| 13 | COMB4 | 48.43 | 63.62 | 897.8 | -442.8 |
| 14 | COMB4 | -145.08 | -452.26 | -1944.03 | 1491.72 |
| 15 | COMB4 | -44.64 | 46.29 | 1042.8 | -155.31 |
| 16 | COMB4 | 48.46 | 63.61 | 902.41 | -442.37 |
| 17 | COMB4 | -144.83 | -452.37 | -1944.98 | 1492.52 |
| 18 | COMB4 | -44.93 | 46.26 | 1038.76 | -155.57 |
| 19 | COMB4 | 48.46 | 63.59 | 906.54 | -441.81 |
| 20 | COMB4 | -144.55 | -452.3 | -1945.4 | 1492.65 |
| 21 | COMB4 | -45.2 | 46.21 | 1034.49 | -155.68 |
| 22 | COMB4 | 48.44 | 63.55 | 910.5 | -441.01 |
| 23 | COMB4 | -144.21 | -452.04 | -1945.22 | 1492.2 |
| 24 | COMB4 | -45.5 | 46.15 | 1029.37 | -155.83 |
| 25 | COMB4 | 48.39 | 63.5 | 914.82 | -439.67 |
| 26 | COMB4 | -143.79 | -451.62 | -1943.17 | 1492.36 |
| 27 | COMB4 | -45.83 | 46.06 | 1024.11 | -156.51 |
| 28 | COMB4 | 48.4 | 63.61 | 916.49 | -439.7 |
| 29 | COMB4 | -143.09 | -451.55 | -1951.58 | 1508.85 |
| 30 | COMB4 | -47.38 | 45.83 | 1024.07 | -151.77 |

Tabel L2.4 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 4 (lanjutan)

| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 31 | COMB4 | 48.2 | 63.63 | 952.69 | -443.58 |
| 32 | COMB4 | -143.74 | -453.5 | -1998.32 | 1460.49 |
| 33 | COMB4 | -46.48 | 46.23 | 1049.47 | -146.18 |
| 34 | COMB4 | 48.28 | 63.76 | 939.62 | -431.89 |
| 35 | COMB4 | -144.56 | -453.31 | -1990.88 | 1468.14 |
| 36 | COMB4 | -46.02 | 46.33 | 1053.8 | -146.42 |
| 37 | COMB4 | 48.22 | 63.75 | 933.28 | -432.85 |
| 38 | COMB4 | -144.84 | -453.04 | -1988.68 | 1467.22 |
| 39 | COMB4 | -45.7 | 46.36 | 1057.82 | -146.11 |
| 40 | COMB4 | 48.19 | 63.76 | 928.67 | -433.28 |
| 41 | COMB4 | -145.09 | -452.93 | -1987.72 | 1466.43 |
| 42 | COMB4 | -45.41 | 46.39 | 1061.86 | -145.85 |
| 43 | COMB4 | 48.18 | 63.78 | 924.54 | -433.84 |
| 44 | COMB4 | -145.38 | -453 | -1987.31 | 1466.3 |
| 45 | COMB4 | -45.13 | 46.44 | 1066.14 | -145.73 |
| 46 | COMB4 | 48.21 | 63.82 | 920.57 | -434.64 |
| 47 | COMB4 | -145.72 | -453.26 | -1987.48 | 1466.75 |
| 48 | COMB4 | -44.84 | 46.49 | 1071.25 | -145.58 |

Tabel L2.5 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 5

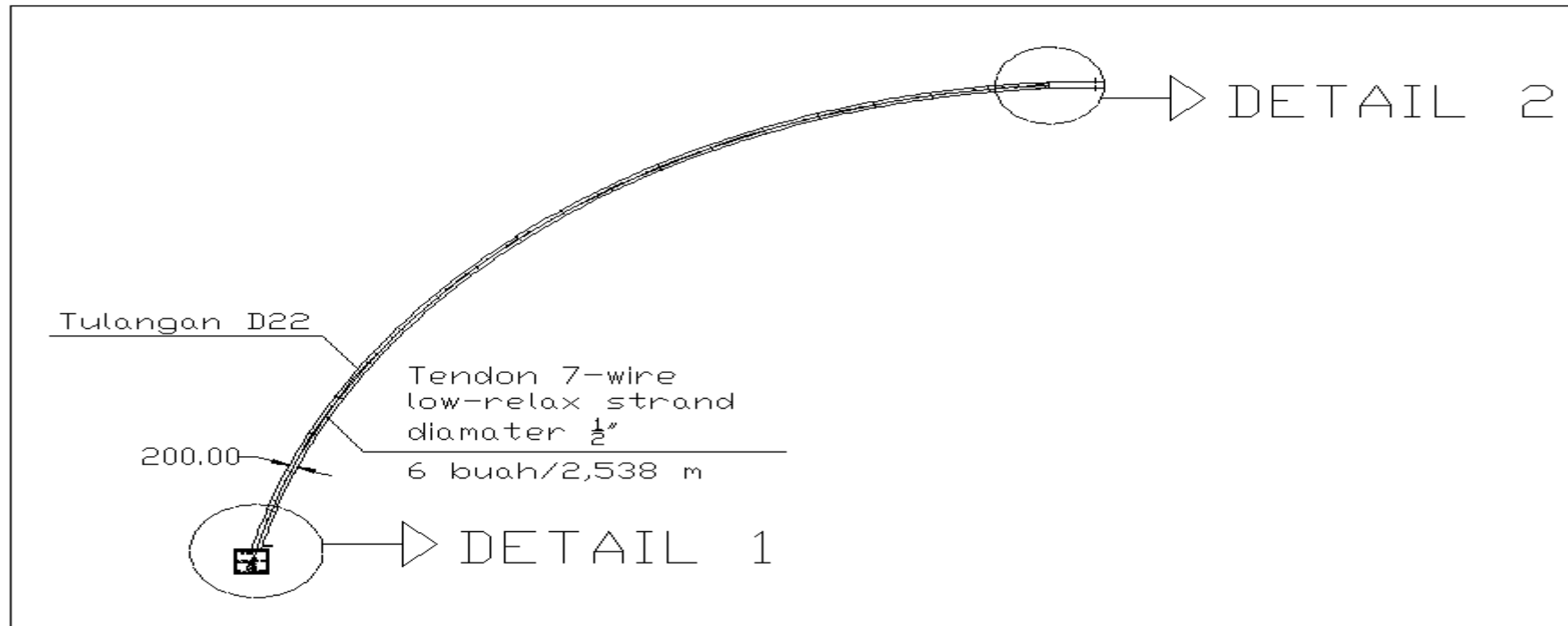
| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|---------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 1 | COMB5 | 31.14 | 43.19 | 650.03 | -253.52 |
| 1 | COMB5 | 31.12 | 43.07 | 668.84 | -250.27 |
| 2 | COMB5 | -97.4 | -301.74 | -1400.97 | 951.14 |
| 3 | COMB5 | -32.36 | 31.34 | 740.18 | -59.36 |
| 4 | COMB5 | 31.13 | 43.18 | 670.51 | -250.3 |
| 5 | COMB5 | -96.69 | -301.67 | -1409.37 | 967.62 |
| 6 | COMB5 | -33.9 | 31.11 | 740.14 | -54.62 |
| 7 | COMB5 | 30.93 | 43.2 | 706.7 | -254.18 |
| 8 | COMB5 | -97.35 | -303.63 | -1456.12 | 919.26 |
| 9 | COMB5 | -33.01 | 31.51 | 765.55 | -49.02 |
| 10 | COMB5 | 31.01 | 43.33 | 693.63 | -242.49 |
| 11 | COMB5 | -98.17 | -303.44 | -1448.67 | 926.92 |
| 12 | COMB5 | -32.54 | 31.62 | 769.88 | -49.26 |
| 13 | COMB5 | 30.95 | 43.33 | 687.3 | -243.45 |
| 14 | COMB5 | -98.45 | -303.16 | -1446.47 | 926 |
| 15 | COMB5 | -32.22 | 31.64 | 773.9 | -48.95 |
| 16 | COMB5 | 30.92 | 43.33 | 682.69 | -243.88 |
| 17 | COMB5 | -98.7 | -303.06 | -1445.52 | 925.2 |
| 18 | COMB5 | -31.93 | 31.68 | 777.94 | -48.69 |
| 19 | COMB5 | 30.91 | 43.36 | 678.55 | -244.44 |
| 20 | COMB5 | -98.99 | -303.13 | -1445.1 | 925.07 |
| 21 | COMB5 | -31.66 | 31.72 | 782.22 | -48.57 |
| 22 | COMB5 | 30.94 | 43.4 | 674.59 | -245.24 |
| 23 | COMB5 | -99.33 | -303.39 | -1445.28 | 925.52 |
| 24 | COMB5 | -31.36 | 31.78 | 787.33 | -48.43 |
| 25 | COMB5 | 30.99 | 43.45 | 670.27 | -246.58 |
| 26 | COMB5 | -99.74 | -303.81 | -1447.33 | 925.36 |
| 27 | COMB5 | -31.03 | 31.88 | 792.6 | -47.74 |
| 28 | COMB5 | 30.98 | 43.33 | 668.6 | -246.54 |
| 29 | COMB5 | -100.45 | -303.88 | -1438.92 | 908.87 |
| 30 | COMB5 | -29.48 | 32.1 | 792.64 | -52.48 |

Tabel L2.5 Table Element Force-Area Shells Tepi Cangkang Bawah Akibat Kombinasi 5 (lanjutan)

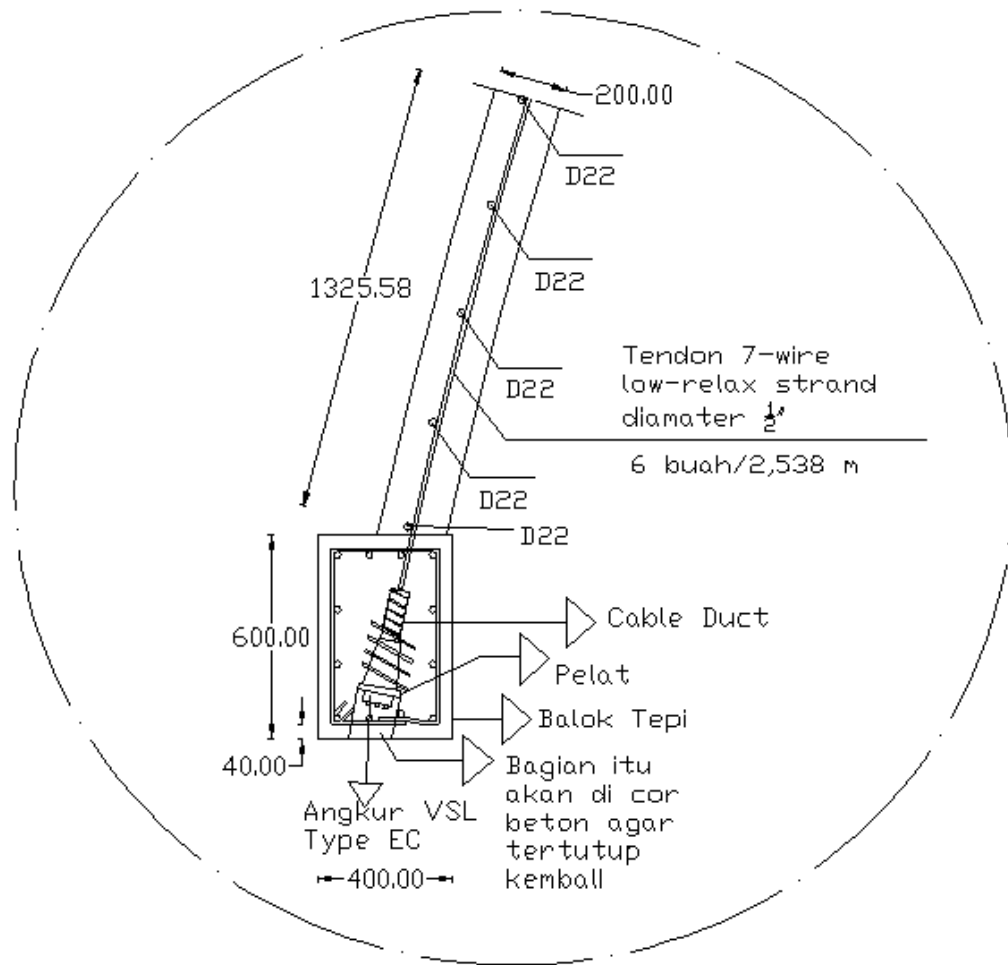
| TABLE: Element Forces - Area Shells | | | | | |
|-------------------------------------|------------|--------|---------|----------|---------|
| Area | OutputCase | F11 | F22 | M11 | M22 |
| Text | Text | N/mm | N/mm | N-mm/mm | N-mm/mm |
| 31 | COMB5 | 31.17 | 43.32 | 632.41 | -242.66 |
| 32 | COMB5 | -99.79 | -301.92 | -1392.18 | 957.23 |
| 33 | COMB5 | -30.38 | 31.71 | 767.23 | -58.08 |
| 34 | COMB5 | 31.09 | 43.18 | 645.48 | -254.36 |
| 35 | COMB5 | -98.97 | -302.12 | -1399.62 | 949.58 |
| 36 | COMB5 | -30.84 | 31.6 | 762.9 | -57.83 |
| 37 | COMB5 | 31.16 | 43.19 | 651.82 | -253.4 |
| 38 | COMB5 | -98.69 | -302.39 | -1401.82 | 950.5 |
| 39 | COMB5 | -31.16 | 31.57 | 758.88 | -58.15 |
| 40 | COMB5 | 31.19 | 43.19 | 656.42 | -252.97 |
| 41 | COMB5 | -98.44 | -302.5 | -1402.78 | 951.3 |
| 42 | COMB5 | -31.45 | 31.54 | 754.84 | -58.41 |
| 43 | COMB5 | 31.19 | 43.16 | 660.56 | -252.41 |
| 44 | COMB5 | -98.15 | -302.42 | -1403.19 | 951.42 |
| 45 | COMB5 | -31.73 | 31.5 | 750.56 | -58.53 |
| 46 | COMB5 | 31.17 | 43.12 | 664.52 | -251.61 |
| 47 | COMB5 | -97.81 | -302.17 | -1403.01 | 950.97 |
| 48 | COMB5 | -32.02 | 31.44 | 745.45 | -58.67 |

LAMPIRAN III

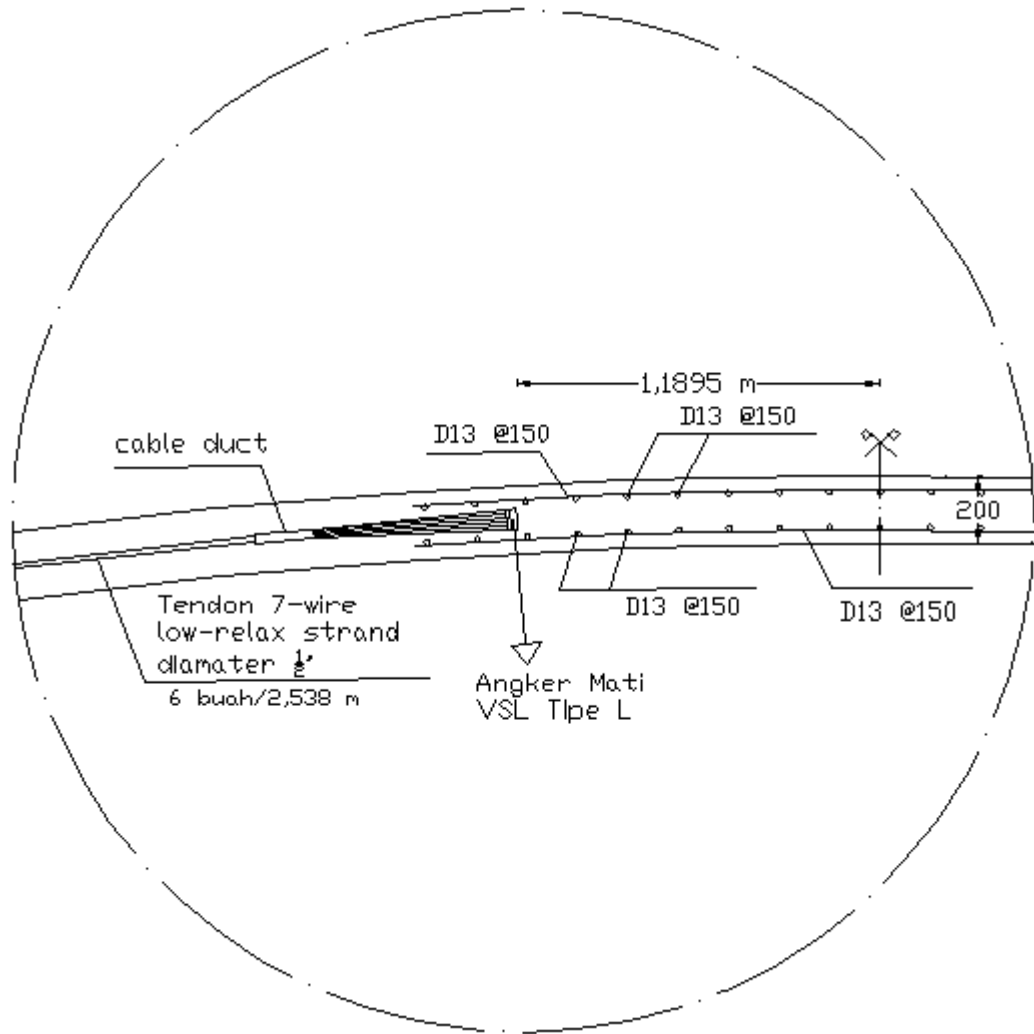
Gambar Penjangkaran Tendon Tangensial



Gambar L3.1 Potongan Vertikal Setengah *Spherical Dome*



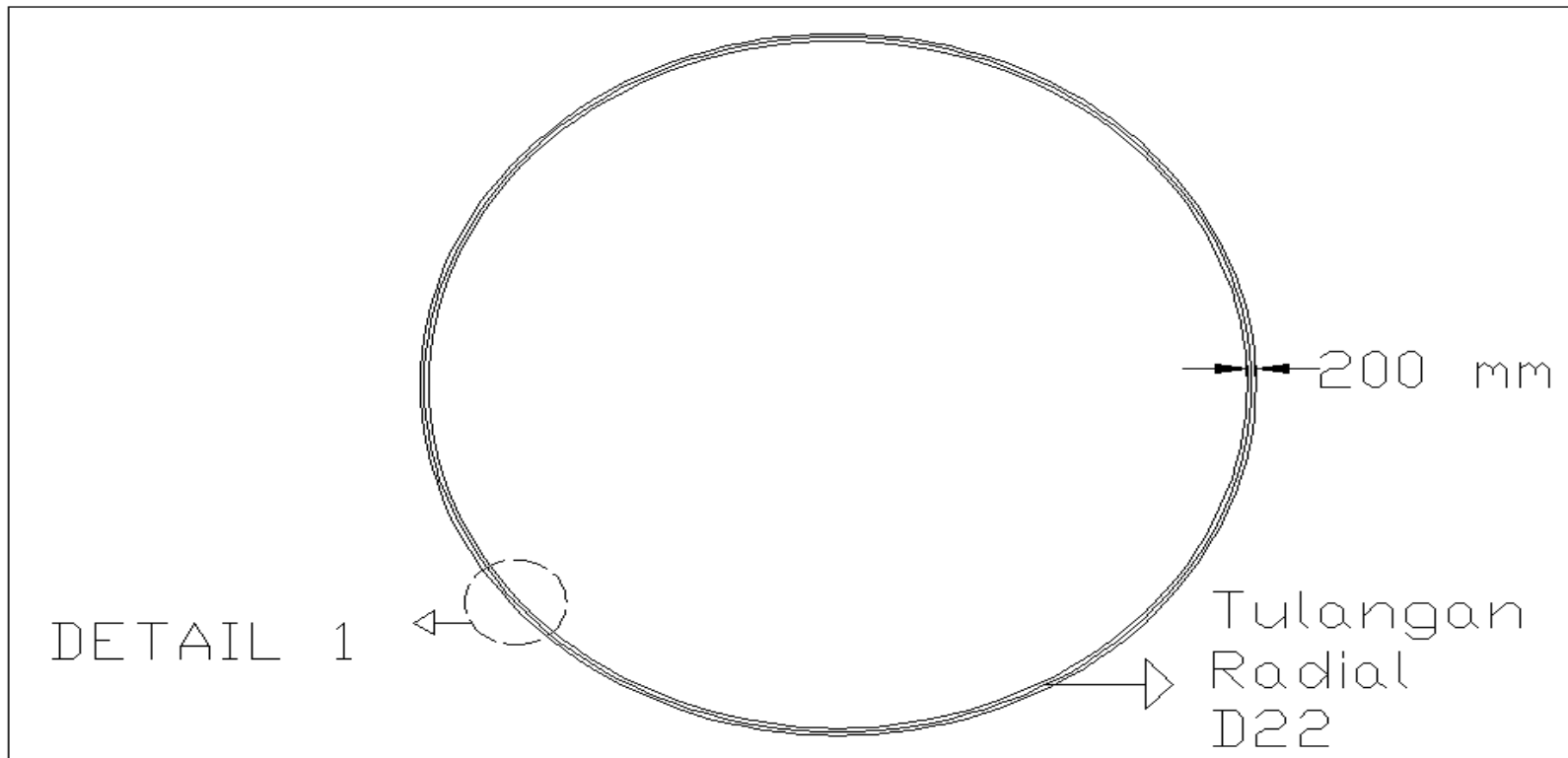
Gambar L3.2 Detail 1 Penjangkaran dari Potongan Vertikal Setengah Spherical Dome



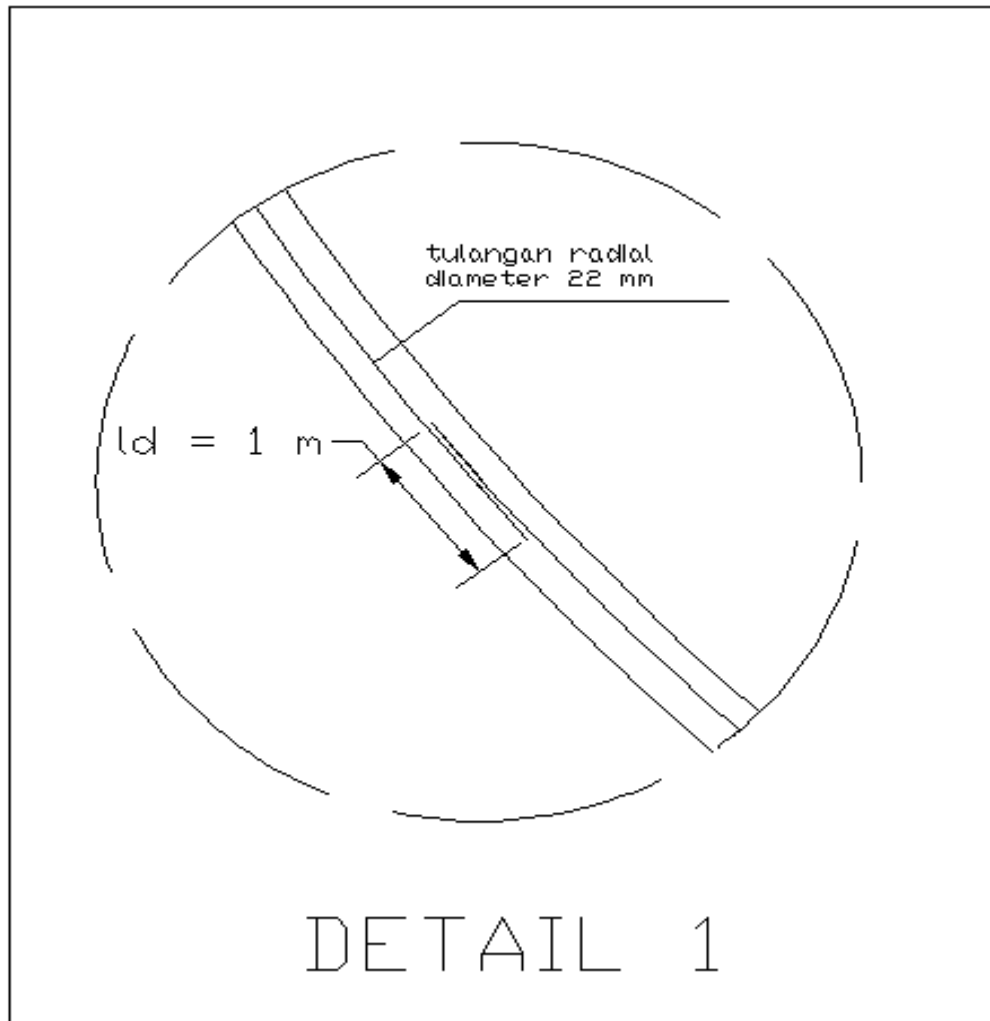
Gambar L3.3 Detail 2 Penjangkaran dari Potongan Vertikal Setengah *Spherical Dome*

LAMPIRAN IV

Gambar Panjang Penyaluran Tulangan Radial



Gambar L4.1 Potongan Horizontal *Spherical Dome*



**Gambar L4.2 Detail 1 Panjang Penyaluran dari Potongan Horizontal
*Spherical Dome***

LAMPIRAN V

Tabel Lendutan Ijin Maksimum Dari Tata Cara Perhitungan Struktur Beton Untuk Bangunan Gedung (SNI 03-2847-2002)

| Jenis komponen struktur | Lendutan yang diperhitungkan | Batas lendutan |
|---|---|----------------------|
| Atap datar yang tidak menahan atau tidak disatukan dengan komponen nonstruktural yang mungkin akan rusak oleh lendutan yang besar | Lendutan seketika akibat beban hidup (L) | $\frac{\ell^3}{180}$ |
| Lantai yang tidak menahan atau tidak disatukan dengan komponen nonstruktural yang mungkin akan rusak oleh lendutan yang besar | Lendutan seketika akibat beban hidup (L) | $\frac{\ell}{360}$ |
| Konstruksi atap atau lantai yang menahan atau disatukan dengan komponen nonstruktural yang mungkin akan rusak oleh lendutan yang besar | Bagian dari lendutan total yang terjadi setelah pemasangan komponen nonstruktural (jumlah dari lendutan jangka panjang, akibat semua beban tetap yang bekerja, dan lendutan seketika, akibat penambahan beban hidup) ^c | $\frac{\ell^3}{480}$ |
| Konstruksi atap atau lantai yang menahan atau disatukan dengan komponen nonstruktural yang mungkin tidak akan rusak oleh lendutan yang besar. | | $\frac{\ell^3}{240}$ |
| <p>a Batasan ini tidak dimaksudkan untuk mencegah kemungkinan penggenangan air. Kemungkinan penggenangan air harus diperiksa dengan melakukan perhitungan lendutan, termasuk lendutan tambahan akibat adanya penggenangan air tersebut, dan mempertimbangkan pengaruh jangka panjang dari beban yang selalu bekerja, lawan lendut, toleransi konstruksi dan keandalan sistem drainase.</p> <p>b Batas lendutan boleh dilampaui bila langkah pencegahan kerusakan terhadap komponen yang ditumpu atau yang disatukan telah dilakukan.</p> <p>c Lendutan jangka panjang harus dihitung berdasarkan ketentuan 11.5.2.5 atau 11.5.4.2, tetapi boleh dikurangi dengan nilai lendutan yang terjadi sebelum penambahan komponen non-struktural. Besarnya nilai lendutan ini harus ditentukan berdasarkan data teknis yang dapat diterima berkenaan dengan karakteristik hubungan waktu dan lendutan dari komponen struktur yang serupa dengan komponen struktur yang ditinjau.</p> <p>d Tetapi tidak boleh lebih besar dari toleransi yang disediakan untuk komponen non-struktur. Batasan ini boleh dilampaui bila ada lawan lendut yang disediakan sedemikian hingga lendutan total dikurangi lawan lendut tidak melebihi batas lendutan yang ada.</p> | | |

Gambar L5. Tabel Lendutan Ijin Maksimum

LAMPIRAN VI

Manual Dari VSL


MULTISTRAND SYSTEM

VSL

Strand Properties

| Strand type | 13 mm (0.5") | | 16 mm (0.6") | |
|--|--|-------------------------|--|-------------------------|
| | Euronorm 138-79 or BS 5896: 1980 Super | ASTM A 416-85 Grade 270 | Euronorm 138-79 or BS 5896: 1980 Super | ASTM A 416-85 Grade 270 |
| Nominal diameter | 12.9 | 12.7 | 15.7 | 15.2 |
| Nominal area | 100 | 98.7 | 150 | 140 |
| Nominal mass | 8.766 | 8.775 | 1.18 | 1.10 |
| Yield strength | 1580 ¹⁾ | 1670 ²⁾ | 1500 ¹⁾ | 1610 ²⁾ |
| Tensile strength | 1860 | 1880 | 1730 | 1880 |
| Min. breaking load P_{br} | 186.0 | 183.7 | 265.0 | 262.7 |
| Young's modulus | 195 GPa | | | |
| Relaxation ³⁾ after 1000 h at 20°C and 0.7 x P_{br} | max. 2.5 | | | |

1) Measured at 0.1% residual strain (0.1% offset method)
 2) Measured at 1.0% extension (0% extension under load method)
 3) Valid for relaxation class 2 acc. to Euronorm 138-79/BS 5896: 1980, or for relaxation grade acc. to ASTM A 416-85.



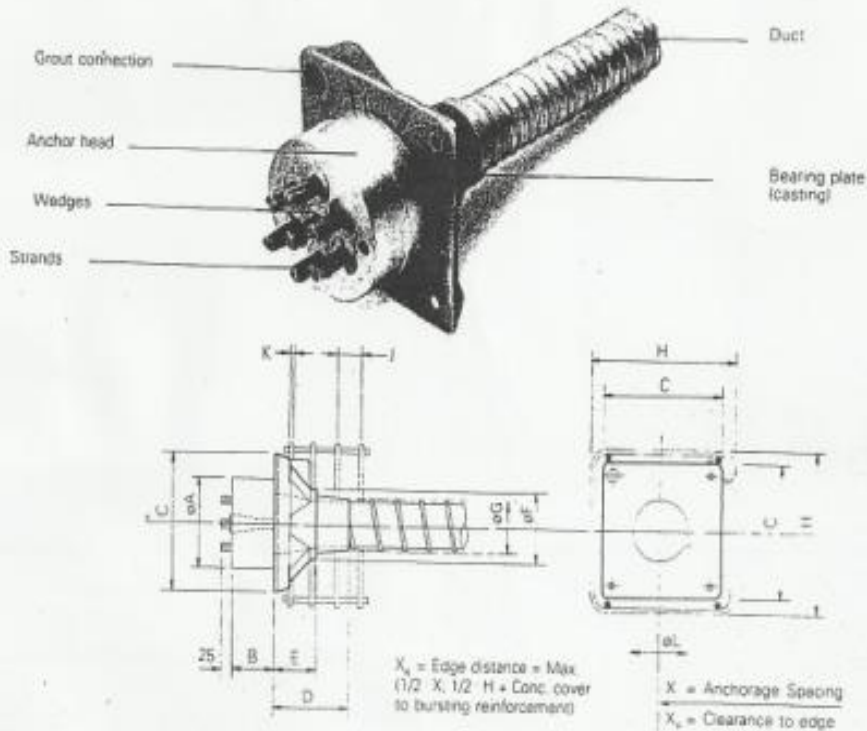
Tendon Properties

| 13 mm (0.5") strand | | | | | 16 mm (0.6") strand | | | | |
|---------------------|-------------------|--|---|---|---------------------|-------------------|--|---|---|
| Tendon unit | Number of strands | Duct diameter ¹⁾ internal/external (mm) | Min. breaking load | | Tendon unit | Number of strands | Duct diameter ¹⁾ internal/external (mm) | Min. breaking load | |
| | | | Strand type Euronorm 138-79 or BS 5896: 1980 Super (kN) | Strand type ASTM A416-85 Grade 270 (kN) | | | | Strand type Euronorm 138-79 or BS 5896: 1980 Super (kN) | Strand type ASTM A416-85 Grade 270 (kN) |
| 6-1 | 1 | 25/32 | 186 | 184 | 6-1 | 1 | 30/36 | 265 | 261 |
| 6-2 | 2 | 35/42 | 372 | 367 | 6-2 | 2 | 35/42 | 530 | 521 |
| 6-3 | 3 | 35/42 | 558 | 551 | 6-3 | 3 | 45/52 | 796 | 782 |
| 6-4 | 4 | 40/47 | 744 | 735 | 6-4 | 4 | 50/57 | 1099 | 1043 |
| 6-6 | 6 | 50/57 | 1116 | 1102 | 6-6 | 6 | 60/67 | 1599 | 1564 |
| 6-7 | 7 | 50/57 | 1302 | 1286 | 6-7 | 7 | 60/67 | 1855 | 1825 |
| 6-12 | 12 | 65/72 | 2232 | 2204 | 6-12 | 12 | 65/72 | 2160 | 2128 |
| 6-18 | 18 | 80/87 | 3348 | 3307 | 6-18 | 18 | 85/102 | 4719 | 4603 |
| 6-22 | 22 | 85/92 | 4080 | 4041 | 6-18 | 18 | 95/102 | 5035 | 4963 |
| 6-27 | 27 | 100/107 | 5022 | 4968 | 6-22 | 22 | 110/117 | 5830 | 5735 |
| 6-31 | 31 | 100/107 | 5766 | 5695 | 6-31 | 31 | 120/127 | 6716 | 6562 |
| 6-37 | 37 | 120/127 | 6882 | 6797 | 6-37 | 37 | 143/147 | 9802 | 9646 |
| 6-42 | 42 | 120/127 | 7812 | 7726 | | | | | |
| 6-55 | 55 | 140/147 | 10230 | 10104 | | | | | |

1) Diameter size for corrugated steel ducts.
 For polyethylene ducts "P-PLUS" see page 6.
 2) For intermediate stressing anchorages type 2.

Lampiran 6.1 Manual Dari VSL

Stressing Anchorage VSL Type EC



| Tendon dia | Strand type 13 mm (0.5") | | | | | | | | | | | Strand type 15 mm (0.6") | | | | | | | | | | | | | |
|---------------|--------------------------|---------|---------|------------------------|----|----|-----|--------------|-----|-----|--------|--------------------------|-----|-----|---------------|------------|---------|---------|------------------------|---------------|-----|-----|--------------|-----|-----|
| | Duct (dia) | | Spacing | Bursting reinforcement | | | | Anchor leads | | | Casing | | | | Tendon dia | Duct (dia) | | Spacing | Bursting reinforcement | | | | Anchor leads | | |
| | Min | Norm | | X | aK | J | H | B | aA | eG | eF | E | D | C | | Min | Norm | | X | No of bars | aK | J | H | B | aA |
| 5-3 | 35/42 | 40/47 | 100 | 3 | 10 | 50 | 140 | 80 | 85 | 58 | 54 | 102 | 125 | | | | | | | | | | | | |
| 5-4 | 43/47 | 43/47 | 100 | 3 | 10 | 50 | 180 | 80 | 85 | 58 | 57 | 102 | 125 | 6-3 | 40/47 | 45/52 | 100 | 3 | 10 | 50 | 180 | 80 | 85 | 90 | 90 |
| 5-7 | 50/57 | 50/57 | 230 | 4 | 12 | 90 | 200 | 80 | 110 | 70 | 85 | 80 | 100 | 105 | 6-4 | 45/52 | 45/52 | 230 | 4 | 12 | 50 | 200 | 80 | 85 | 110 |
| 5-12 | 80/87 | 85/72 | 300 | 5 | 16 | 55 | 270 | 58 | 150 | 92 | 120 | 85 | 100 | 215 | 6-7 | 55/52 | 80/87 | 300 | 5 | 16 | 50 | 270 | 58 | 150 | |
| 5-19 | 75/82 | 80/87 | 380 | 6 | 16 | 55 | 350 | 70 | 180 | 107 | 145 | 110 | 210 | 285 | 6-12 | 75/82 | 80/87 | 380 | 6 | 16 | 55 | 350 | 70 | 180 | |
| 5-22 | 80/87 | 85/82 | 420 | 6 | 20 | 65 | 380 | 77 | 200 | 112 | 130 | 140 | 215 | 290 | | | | | | | | | | | |
| 5-27 | 95/102 | 100/107 | 490 | 7 | 20 | 65 | 480 | 92 | 220 | 145 | 175 | 160 | 250 | 315 | 6-18 | 95/102 | 100/107 | 490 | 7 | 20 | 60 | 480 | 92 | 220 | |
| 5-31 | 95/102 | 100/107 | 490 | 7 | 20 | 65 | 480 | 100 | 230 | 145 | 175 | 160 | 250 | 315 | 6-22 | 100/107 | 100/107 | 490 | 7 | 20 | 60 | 480 | 100 | 230 | |
| 5-37 | 130/137 | 130/137 | 530 | 7 | 20 | 70 | 580 | 107 | 250 | 134 | 200 | 180 | 320 | 370 | | | | | | | | | | | |
| 5-42 | 120/127 | 120/127 | 565 | 8 | 22 | 70 | 530 | 112 | 280 | 144 | 210 | 190 | 340 | 390 | 6-34 | 120/127 | 120/127 | 560 | 8 | 22 | 65 | 530 | 122 | 270 | |
| 5-55 | 130/137 | 140/147 | 680 | 8 | 22 | 70 | 620 | 130 | 320 | 155 | 230 | 200 | 340 | 405 | 6-37 | 130/137 | 140/147 | 680 | 8 | 22 | 65 | 620 | 142 | 300 | |

Dimensions in mm

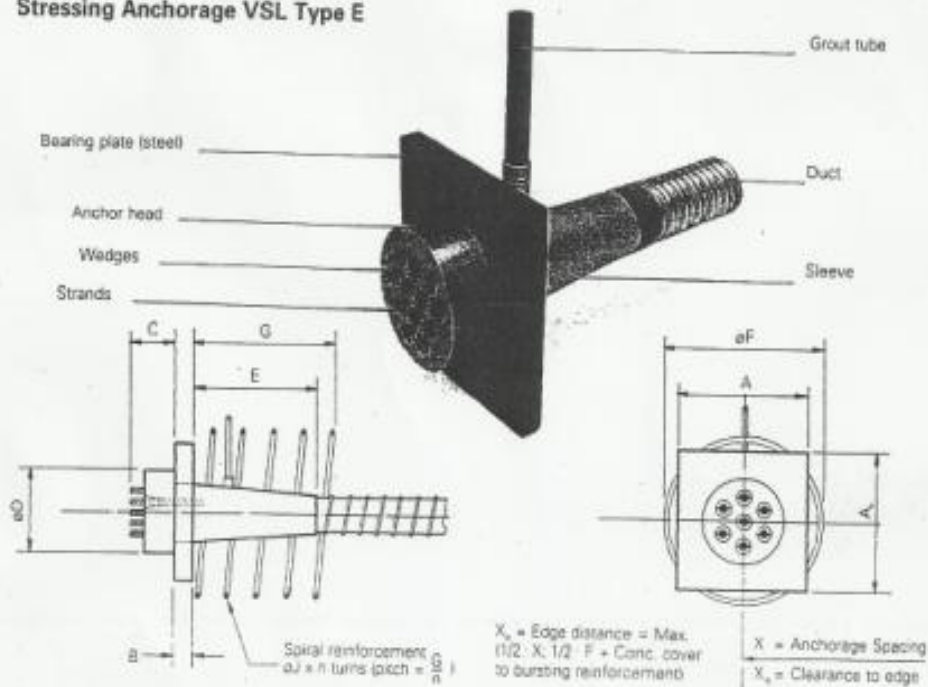
- Min and normal duct diameters are for corrugated steel ducts. Locally available diameters may vary slightly. For polyethylene ducts PT-PLUS™ refer to page 6.
- Anchorage dimensions/spacings and bursting reinforcement are based on: nominal concrete cube strength at transfer: 24 MPa; nominal concrete cube strength at 28 days: 30 MPa; breaking load for a 13mm (0.5") strands 186 kN

Subject to modification

breaking load for a 15mm (0.6") loads 265 kN
 yield strength of bursting reinforcement ≥ 400 MPa
 maximum prestressing force at transfer: 80% of tendon breaking load
 maximum prestressing force after wedge draw-in: 75% of tendon breaking load
 Dimensions for other concrete strength on request.

Lampiran 6.2 Spesifikasi Stressing Anchorage VSL Type EC

Stressing Anchorage VSL Type E



| | Tendon type | A | B | C | eD | E | eF | G | H recomm- ended | eJ | n | X ^a |
|--------------------------|----------------|-----|-----|-----|-----|-----|-----|---------|-----------------------|----|-----|----------------|
| Strand type 13 mm (0.5") | 5-1 | 70 | 15 | 75 | 42 | 70 | 80 | 90 | 25/30 | 8 | 2 | 90 |
| | 5-3 | 115 | 20 | 80 | 90 | 100 | 130 | 150 | 40/45 | 10 | 3 | 155 |
| | 5-4 | 130 | 20 | 80 | 95 | 100 | 100 | 150 | 45/50 | 10 | 3 | 180 |
| | 5-7 | 175 | 25 | 85 | 110 | 100 | 205 | 200 | 55/60 | 12 | 4 | 235 |
| | 5-12 | 230 | 35 | 90 | 150 | 370 | 285 | 250 | 65/72 | 14 | 5 | 305 |
| | 5-19 | 290 | 40 | 105 | 180 | 470 | 368 | 300 | 80/87 | 16 | 6 | 385 |
| | 5-22 | 315 | 45 | 115 | 190 | 480 | 395 | 360 | 85/92 | 18 | 6 | 415 |
| | 5-31 | 370 | 55 | 125 | 220 | 550 | 470 | 400 | 100/107 | 18 | 8 | 490 |
| | 5-37 | 405 | 60 | 130 | 240 | 570 | 510 | 420 | 120/127 | 20 | 7 | 535 |
| | 5-43 | 440 | 60 | 145 | 260 | 680 | 550 | 480 | 130/137 | 20 | 8 | 580 |
| 5-55 | 500 | 70 | 160 | 290 | 680 | 620 | 540 | 140/150 | 22 | 9 | 655 | |
| Strand type 15 mm (0.6") | 6-1 | 75 | 15 | 80 | 53 | 70 | 80 | 90 | 30/35 | 8 | 2 | 105 |
| | 6-2 | 110 | 15 | 80 | 90 | 100 | 130 | 150 | 45/50 | 10 | 3 | 150 |
| | 6-3 | 135 | 20 | 80 | 95 | 100 | 160 | 160 | 45/50 | 10 | 3 | 185 |
| | 6-4 | 160 | 25 | 85 | 110 | 100 | 190 | 200 | 50/55 | 12 | 4 | 210 |
| | 6-7 | 205 | 35 | 90 | 135 | 290 | 260 | 250 | 60/67 | 14 | 5 | 280 |
| | 6-12 | 270 | 40 | 105 | 170 | 480 | 345 | 300 | 80/87 | 16 | 6 | 365 |
| | 6-19 | 340 | 50 | 125 | 200 | 590 | 440 | 350 | 95/102 | 18 | 7 | 460 |
| | 6-22 | 370 | 55 | 130 | 220 | 690 | 470 | 400 | 110/117 | 18 | 8 | 495 |
| | 6-31 | 435 | 65 | 150 | 260 | 890 | 560 | 480 | 130/137 | 20 | 8 | 590 |
| | 6-37 | 480 | 70 | 165 | 270 | 830 | 610 | 540 | 140/150 | 22 | 9 | 640 |
| 6-43 | 520 | 75 | 175 | 300 | 950 | 650 | 640 | 150/160 | 26 | 8 | 690 | |
| 6-55 | 580 | 90 | 190 | 320 | 950 | 740 | 630 | 170/180 | 26 | 9 | 780 | |

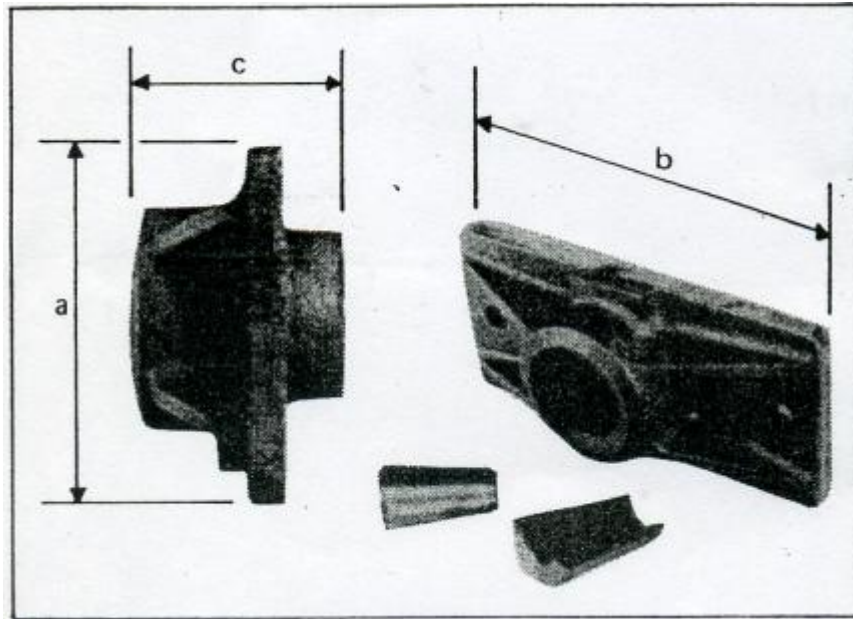
Dimensions in mm

- Recommended duct diameter are for corrugated steel ducts. Locally available diameters may vary slightly. For polyethylene ducts PT-PLUS[®] refer to page 6.
- Anchorage dimensions and bursting reinforcement are based on: nominal concrete cube strength at transfer: 24 MPa nominal concrete cube strength at 28 days: 30 MPa breaking load for a 13mm (0.51) strands: 186 kN

- breaking load for a 15mm (0.6") loads: 265 kN
- yield strength of bursting reinforcement: 400 MPa
- maximum prestressing force at transfer: 80% of tendon breaking load
- maximum prestressing force after wedge draw-in: 75% of tendon breaking load
- Dimensions for other concrete-strengths on request

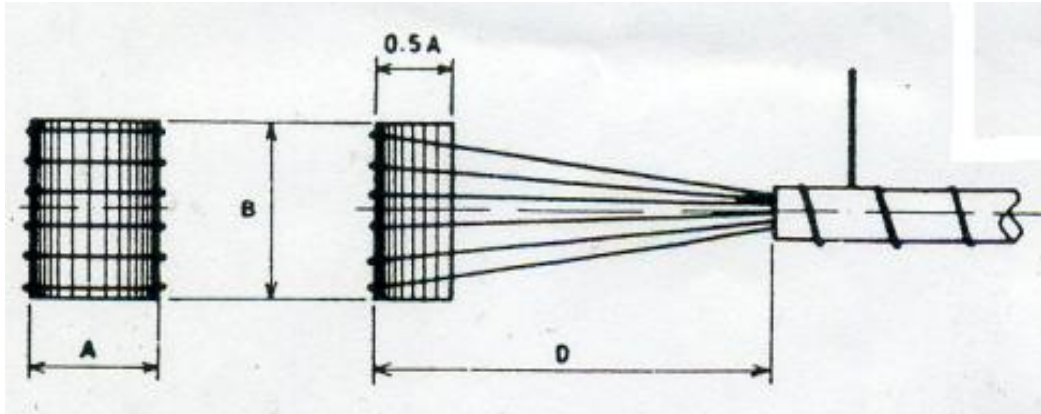
Subject to modification

Lampiran 6.3 Spesifikasi Stressing Anchorage VSL Type E



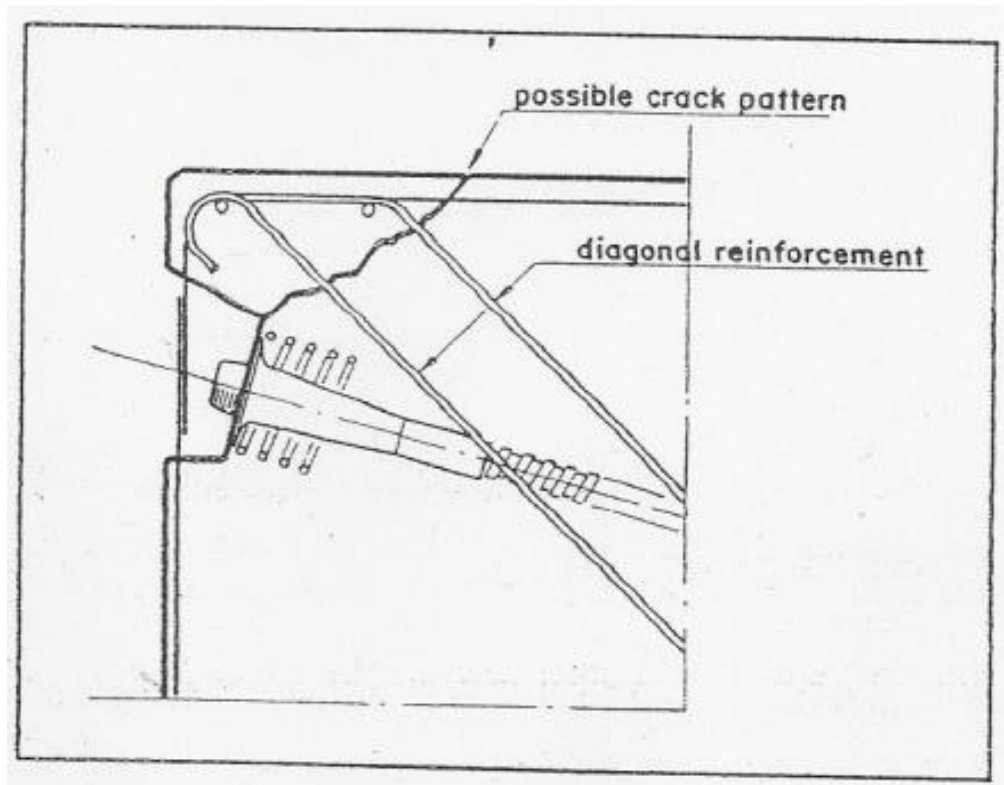
| Tipe | a (mm) | b (mm) | c (mm) |
|-------------|---------------|---------------|---------------|
| S 5N | 60 | 125 | 40 |

Lampiran 6.4 Spesifikasi *Bearing Plate VSL Type SN*



| Tipe | Ukuran (mm) | | | Beban karakteristik (ton) |
|------|-------------|-----|------|---------------------------|
| | A | B | D | |
| 1U | 225 | 16 | 600 | 18,7 |
| 3U | 225 | 75 | 600 | 56,2 |
| 7U | 225 | 175 | 600 | 131,2 |
| 12U | 225 | 275 | 700 | 225,0 |
| 19U | 225 | 400 | 800 | 356,2 |
| 31U | 225 | 640 | 1300 | 581,2 |

Lampiran 6.5 Spesifikasi Angker-Mati VSL Type U



Lampiran 6.6 Detail Penjangkaran

Lampiran VII

Langkah-Langkah Menambahkan Gaya Prategang Tendon

1. Tendon yang digunakan mempunyai luas 98,7 mm². Data-data tendon yang diperlukan:

$$\begin{aligned} \text{Specify Tendon Area} &= \text{jumlah tendon} \times 98,7 \\ &= 6 \times 98,7 = 592,2 \text{ mm}^2 \end{aligned}$$

Setelah itu pilih menu *Define*, pilih *Section Properties*, pilih *Tendon Section*, kemudian pilih *Add New Property* seperti yang terlihat pada gambar L7.1 di bawah ini.

Tendon Section Data

Tendon Section Name TEN1
Section Notes

Tendon Modeling Options For Analysis Model
 Model Tendon as Loads
 Model Tendon as Elements

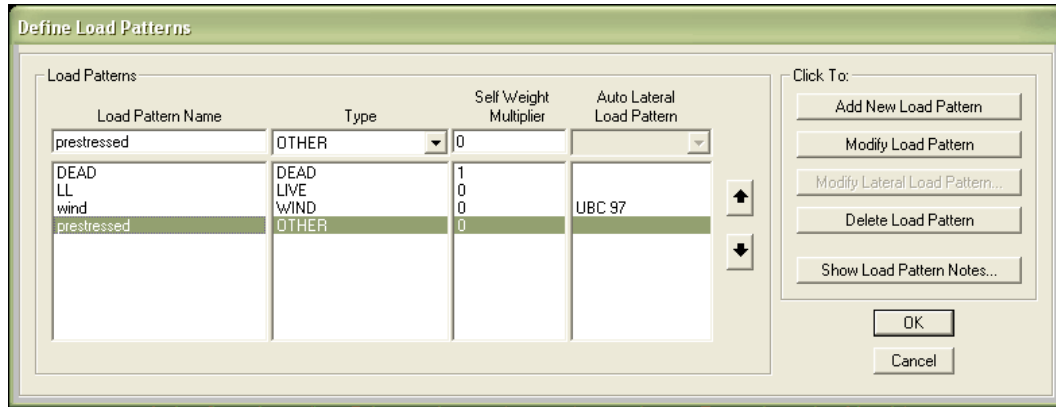
Tendon Parameters
Prestress Type Prestress
Material Property + A416Gr270

Tendon Properties
 Specify Tendon Diameter 27.4593
 Specify Tendon Area 592.2
Torsional Constant 55815.77
Moment of Inertia 27907.886
Shear Area 532.98

Units
N, mm, C Display Color

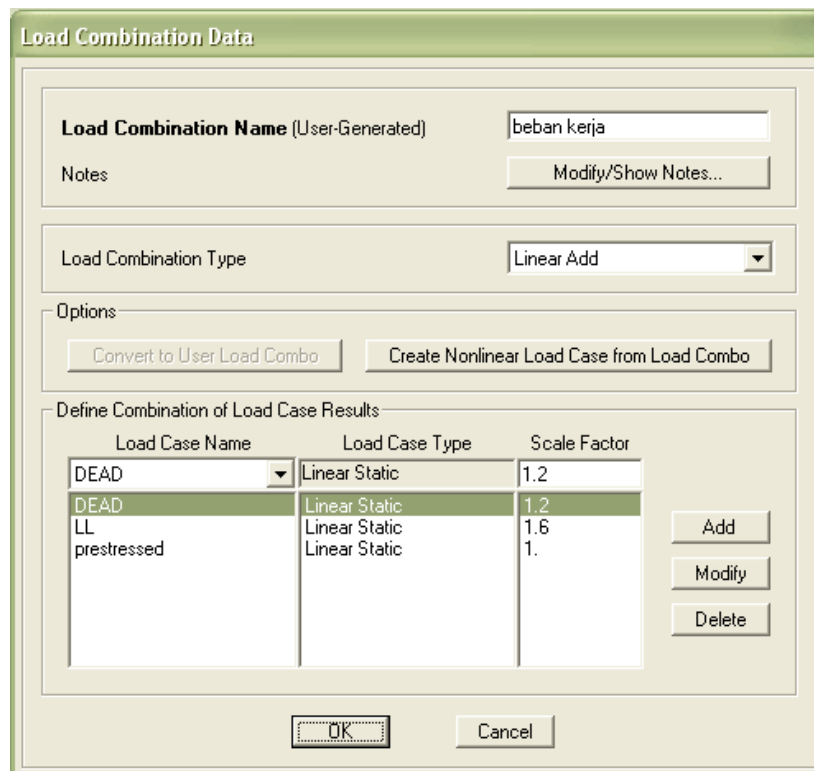
L7.1 Input Data Tendon

2. *Input* definisi beban yang berpengaruh pada struktur cangkang tersebut seperti gambar L7.2 di bawah ini.



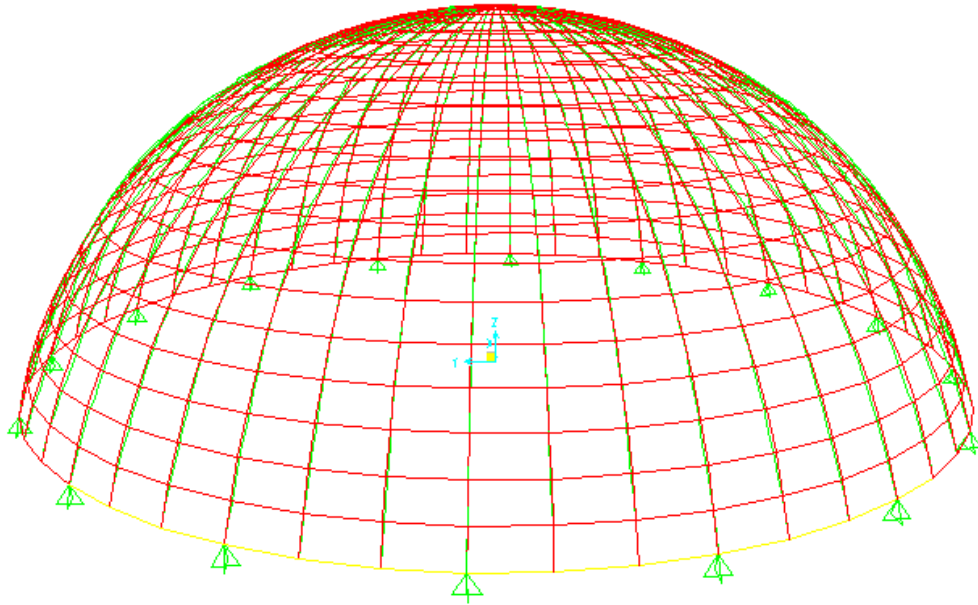
L7.2 Define Loads

3. *Input* kombinasi faktor beban kerja seperti gambar L7.3 di bawah ini.



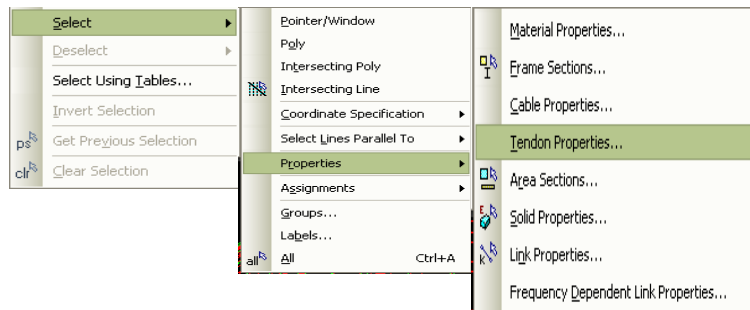
L7.3 Kombinasi Beban Kerja

4. Gambar tendon pada struktur cangkang menggunakan perintah *draw frame*. Tendon ditunjukkan oleh garis yang berwarna hijau pada gambar L7.4.



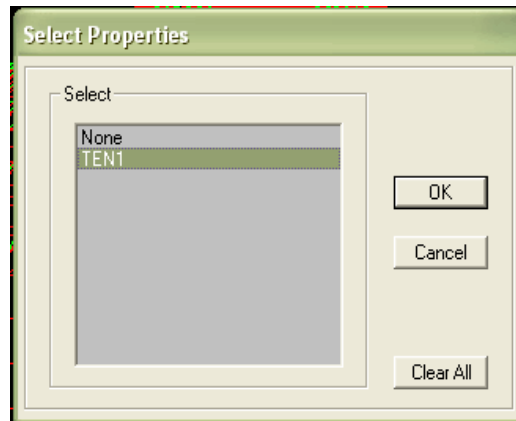
L7.4 Struktur *Spherical Dome* Dengan Tendon

5. Pemberian beban pada tendon dilakukan dengan langkah-langkah seperti di bawah ini:
 - a. Pilih menu *select*, setelah itu pilih *properties*, lalu pilih *tendon properties* agar semua tendon dapat dipilih sekaligus. Seperti yang terlihat pada gambar L7.5 di bawah ini.



L7.5 Langkah-Langkah *Select Tendon*

Selanjutnya pilih TEN1, seperti yang terlihat pada gambar L7.6 di bawah ini.



L7.6 Select Properties

6. Untuk memasukkan gaya pada tendon yaitu dengan memilih *assign*, lalu pilih *tendon loads*, lalu pilih *tendon force/stress*.

Dengan data sebagai berikut:


- a. *Force* = 771044,4 N
- b. *Load Pattern Name* = *Prestressed*
- c. *Jack From This Location* = *I-End (Start) of Tendon*
- d. *Curvature Coefficient* = 0,2
- e. *Anchorage Set Slip* = 6,5 mm

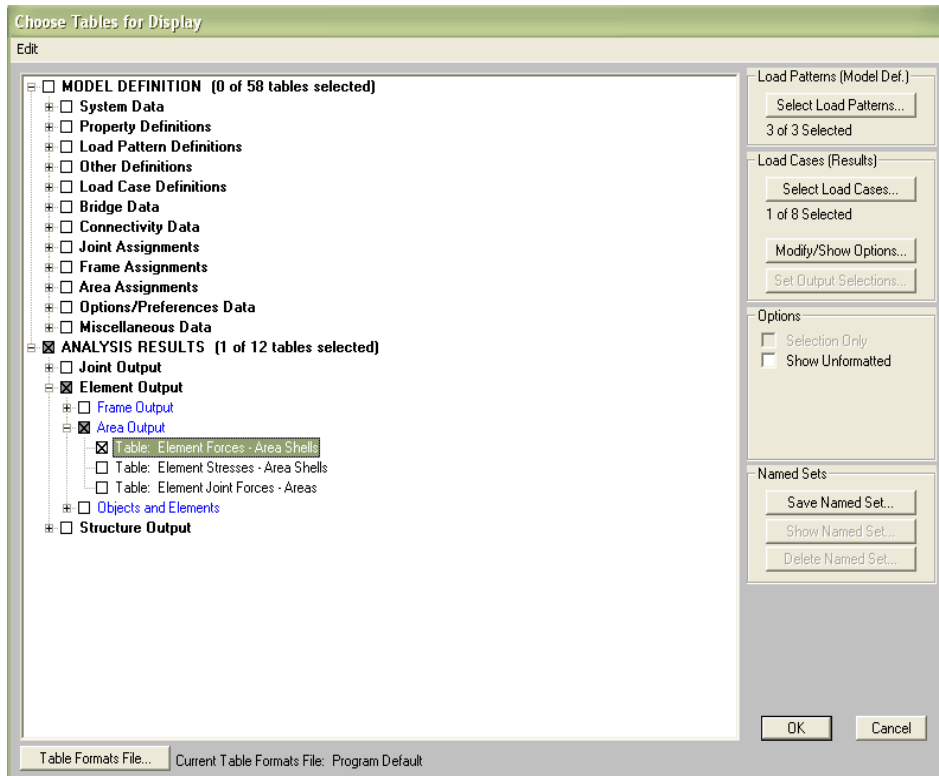
Karena tendon didefinisikan sebagai beban maka *other loss parameters* diisi.

- a. *Elastic Shortening Stress* = 18,173 N/mm²
- b. *Creep Stress* = 51,985 N/mm²
- c. *Shrinkage Stress* = 31,004 N/mm²
- d. *Steel Relaxation Stress* = 80,841 N/mm²

Data-data yang telah dimasukkan dapat dilihat pada gambar L7.7 di bawah ini.

L7.6 Tendon Load

7. Kemudian pilih toolbar *run* , tetapi *modal* di klik *run/do not run*.
8. Untuk mengeluarkan data-data hasil analisis pada program SAP 2000, pilih menu *Display*, kemudian pilih *Show Table*. Pada kotak dialog tersebut pilih *Element Output* → *Area Output* → *Table : Element Forces – Area Shells* → OK seperti yang ditunjukkan pada Gambar L7.7. Tabelnya dapat dilihat pada gambar L7.8.



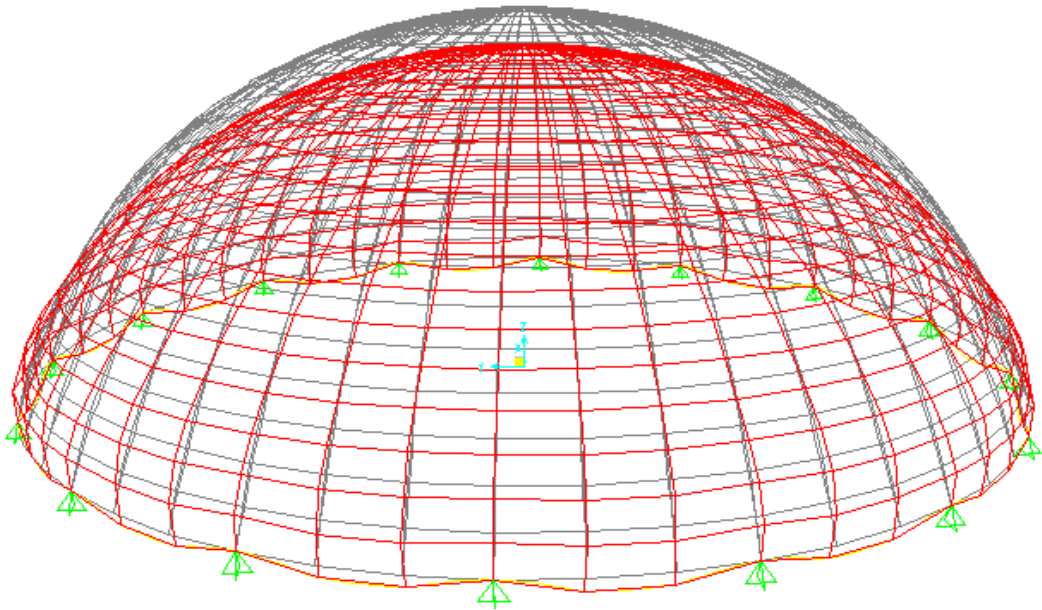
L7.7 Choose tables for Display

| Area Text | AreaElem Text | ShellType Text | Joint Text | OutputCase Text | CaseType Text | F11 N/mm | F22 N/mm | F12 N/mm |
|-----------|---------------|----------------|------------|-----------------|---------------|----------|----------|----------|
| 1 | 1 | Shell-Thin | 1 | beban kerja | Combination | -38.77 | -152.65 | -37.88 |
| 1 | 1 | Shell-Thin | 2 | beban kerja | Combination | -38.77 | -152.63 | 37.95 |
| 1 | 1 | Shell-Thin | 3 | beban kerja | Combination | -16.35 | -144.17 | 38.08 |
| 1 | 1 | Shell-Thin | 4 | beban kerja | Combination | -16.36 | -144.2 | -38.08 |
| 2 | 2 | Shell-Thin | 2 | beban kerja | Combination | -141.74 | -171.67 | 151.73 |
| 2 | 2 | Shell-Thin | 5 | beban kerja | Combination | -248.56 | -705.8 | 129.13 |
| 2 | 2 | Shell-Thin | 6 | beban kerja | Combination | 36.79 | -653.23 | 87.86 |
| 2 | 2 | Shell-Thin | 3 | beban kerja | Combination | 144.39 | -115.21 | 106.35 |
| 3 | 3 | Shell-Thin | 5 | beban kerja | Combination | -248.58 | -705.8 | -129.24 |
| 3 | 3 | Shell-Thin | 7 | beban kerja | Combination | -141.76 | -171.7 | -151.8 |
| 3 | 3 | Shell-Thin | 8 | beban kerja | Combination | 144.38 | -115.23 | -106.28 |
| 3 | 3 | Shell-Thin | 6 | beban kerja | Combination | 36.78 | -653.24 | -87.82 |
| 4 | 4 | Shell-Thin | 7 | beban kerja | Combination | -38.79 | -152.65 | -37.95 |
| 4 | 4 | Shell-Thin | 9 | beban kerja | Combination | -38.79 | -152.65 | 37.91 |
| 4 | 4 | Shell-Thin | 10 | beban kerja | Combination | -16.38 | -144.2 | 38.13 |
| 4 | 4 | Shell-Thin | 8 | beban kerja | Combination | -16.38 | -144.2 | -38.05 |
| 5 | 5 | Shell-Thin | 9 | beban kerja | Combination | -141.78 | -171.7 | 151.75 |
| 5 | 5 | Shell-Thin | 11 | beban kerja | Combination | -248.59 | -705.79 | 129.17 |
| 5 | 5 | Shell-Thin | 12 | beban kerja | Combination | 36.79 | -653.21 | 87.9 |
| 5 | 5 | Shell-Thin | 10 | beban kerja | Combination | 144.39 | -115.23 | 106.38 |

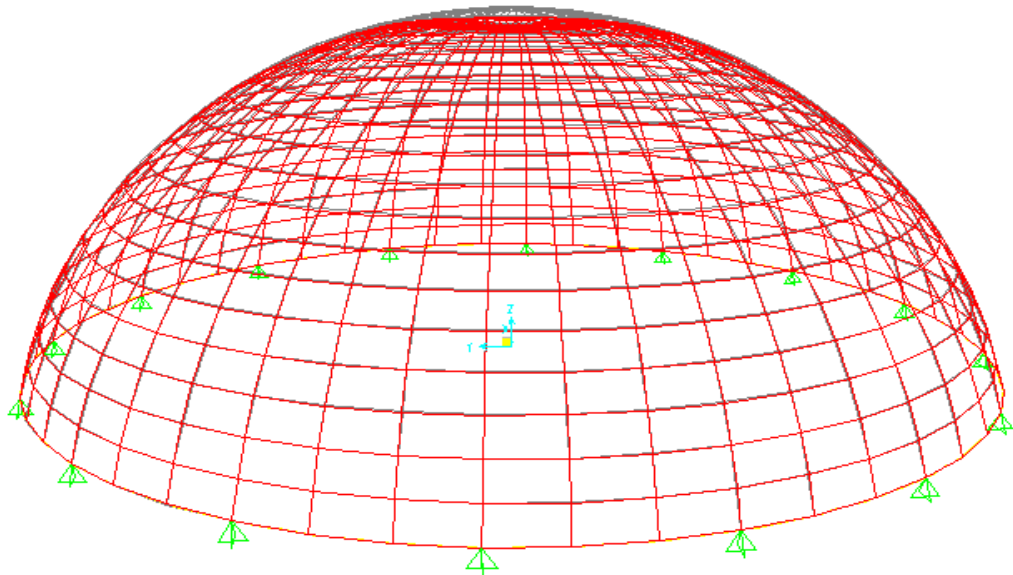
L7.7 Element Forces-Area Shells

Lampiran VIII

Gambar Perbandingan Struktur Tanpa Tendon dan Struktur Dengan Tendon



L8.1 Deformasi Struktur Tanpa Tendon



L8.2 Deformasi Struktur Dengan Tendon