4.4 Building Work

4.4.1 General Description

4.4.1.1 General

The major design criteria applied in calculations are standerd requirements conforming to "Architectural Institute of Japan Standard for Structural Calculation of Rainforced Concrete Structures and Commentary" and "Architecteral Institute of Japan Standard for Structural Calcuration of Steel Structures". 2

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## 4.4.1.2 Design Criteria

Loading Condition

In this structural calcurations, the loads and external forces that act on the structure are the following.

(A) Dead load(B) Live load

Table 1 Combination of Loads

| Condition o      | f Stresses  | Combination of Stress |  |
|------------------|-------------|-----------------------|--|
| Permanent stress | Normal time | G + P                 |  |

where ;

G ; stress due to dead load P ; stress due to live load

The dead and live loads of each part of building are applied in accordance with the Japanese Building Standard Law Enforcement Order.

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4.4.1.3 Structural Analysis (1) Structural analysys Stress analysys of reinforced concrete frames are carried out through a computer, NEC PC-9801. Structural analysys for the vertical and holizontal load is obtained through the stiffnsee matrix method considering the axial, flexual and shering deformations based on elastic theory. (2) Moduius of Elasticity Module of elasticity are as follows ; Concrete ; Bc = 215.2 t/cm2Steel : Es = 2100 t/cm2Shear modulus of elasticity as follows ; Concrete ; Gc = 92.2 t/cm2Steel ;  $Gs = 810 t/cm^2$ 4.4.1.4 Design of Members The design of reinforced concrete structure shall be based on "All Standerd for structural Calculation of Reinforced Concrete Structure". Compressive strength of concrete at 28 days shall be 210 Kg/cm2 and more. Reinforcement bar materials shall comply with deformed bar, "SD295", (JIS G 3112) Weight of reinforced concrete shall be calculated as 2.4 t/m3 and the "Young Ratio" of reinforcement bar to concrete shall be "n = 15".

No. \_\_\_\_4

4.4.1.5 Allowable Design Stress of Materials

(1) Concrete and Reinforcing Bar

Allowable design stress of concrete and reinforcing bar will be summarized as follows :

|                           | Tension | Compression | Shear |
|---------------------------|---------|-------------|-------|
| Concrete<br>(Fc=210kg/cm2 |         | Fc/3 = 70   | 4.25  |
| Rainbar<br>(JIS G 3112)   | 1800    | 1800        | 1000  |

Allowable bond stress per unit surface of reinforcing bar shall be shown as follows ;

|          | :          |
|----------|------------|
| Top bars | Other bars |
| Fc/15    | Fc/10      |
| 14.0     | 21.0       |
|          | Fc/15      |

Top bar , in reference to load, shall be holizontal bar so placed that more than 30cm of concrete is casted in the member below the bar.

(2) Allowable Bearing Capacity of Soil

The bearing capacity of soil is 30 t/m2 for permanent load.

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## 4,4.2 Dam Control House

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§ .1 ASSUMED LOAD

#### FLOOR LOAD TABLE

| TITLE   | MATERIAL                        |              | TICK.       | WEIGHT          |                          | DL      | LL                       | TL         | NOTE |
|---------|---------------------------------|--------------|-------------|-----------------|--------------------------|---------|--------------------------|------------|------|
|         |                                 | (t/m3)       | (cm)        | (kg/m2)         |                          | (kg/m2) | (kg/m2)                  | (kg/m2)    |      |
|         | WATER PROOFING<br>CEMENT MORTAR | 2.00<br>2.40 | 2.0<br>12.0 | 10<br>40<br>288 | TO<br><u>FLOOR</u><br>TO |         | 180                      | 540        |      |
| ROOF    | SLAB<br>CEILING                 | 2,40         | .12.0       | 200             | BEAM                     | 360     | 180                      | 540        |      |
|         |                                 |              |             |                 | PRAME                    | 24 A    | 130                      | 490        |      |
|         |                                 |              |             |                 |                          |         | $(a_1, a_2, \dots, a_n)$ |            |      |
|         | FINISHED<br>SLAB                | 2,00<br>2,40 | 3.0<br>13.0 | 312             |                          |         | 300                      | 700        |      |
| FLOOR   | CEILING                         |              | ľ           | . 20            | TO<br>B <u>BAM</u><br>TO | 400     | 300                      | 700        |      |
|         |                                 |              |             |                 | PRAME                    |         | 180                      | 580        |      |
|         |                                 |              |             |                 |                          |         |                          | . <u> </u> |      |
|         | WATER PROOFING<br>CEMENT MORTAR | 2,00         | 2.0         |                 | FLOOR                    |         | 180                      | 610        |      |
| CANOPY  | SLAB<br>CEILING                 | 2,40         | 15,0        | 360<br>20       |                          | 430     | 180                      | 610        |      |
|         |                                 |              | · .         |                 | FRAME                    |         | 130                      | 560        |      |
|         |                                 |              |             |                 |                          |         |                          |            |      |
|         | CEMENT MORTAR                   | 2.00<br>2.40 | 2.0<br>16.5 | 396             | FLOOR                    |         | 180                      | 640        |      |
| BALCONY | CEILING                         |              | :           | 20              | BEAM                     | . 460   | 180                      | 640        |      |
| . *     |                                 | ÷            | 1           |                 | TO<br>PRAME              |         | 130                      | 590        |      |
|         |                                 |              |             |                 |                          | 14 A.   |                          |            |      |



() GIRDER BEAM

| <pre>() OIRDER,1</pre> | DEAN              |       |      |                 |                        |              |
|------------------------|-------------------|-------|------|-----------------|------------------------|--------------|
|                        | NO                | В     | D    | CONCRETE        | FINISHED               | WEIGHT       |
|                        |                   | 25.0  | 60.0 | 288             | 63                     | 36           |
|                        |                   | 25.0  | 80.0 | 408             | 83                     | 50           |
|                        |                   | 35.0  | 60.0 | 504             | 0                      | 51           |
| 2 COLUMN               | •                 |       |      |                 | :                      |              |
|                        | NO                | 8     | 0    | CONCRETE        | FINISHED               | WEIGHT       |
|                        |                   | 30.0  | 30.0 | 216             | 65                     | 29           |
| () WALL                |                   |       |      |                 |                        |              |
|                        | <u>N0</u>         | t     |      | CONCRETE        | PINISHBD               | WBIGHT       |
|                        | <u>N0</u><br>CB20 | t20.0 |      | CONCRETE<br>310 | <u>FINISHED</u><br>100 | WBIGHT<br>41 |
|                        |                   |       |      |                 |                        |              |
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|                        |                   |       |      |                 |                        |              |
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S. > PREPARTORY CALCULATION S-1 CALCULATION OF AXIAL FORCE OF COLUMNS ₩ (ι) ì FLOOR TITLE CALCULATION Σ¥ NO (1) c -1 د. ROOF 0.971 . 6 1 7.0 3.8 0.36, (2.3+2.7) 1.8 1. e. 291. 1. 6 /2 0.5 6.1 FiL. ł 0.69 + 2.6 + 3.6 3.5 1.8 4 0.29×4.6 е 1.0 7.3 13.4 F 0.49 + 5.0 [a: \_\_\_\_ 5.5 p. 41 x 5.0 x 2.0 68.22\_ 6.2 89 33.3 0.5 8-1 ROOL p. 19 x 2. 6 + 1.0 . \$ .1\_ a. 36 x (3. 3 + 3.7) 5 <u>د. د</u> C. <u>n.</u> 6 7.9 2.681 3-6 x 4.0 Ic. 2 <u>\_\_\_\_</u> 占 3.2 C 1.0 13.8 0.41 × 3.7 × 3.0 C.B.20\_\_\_ 4.6 21.5 F 14 0.93x 3.7 1.6 C <u>. . . .</u> CRAD <u>-4.P</u> 47 283 0.9 × 9.0 × 1.0 C ~ 2 د Root 5.9.\_. 4\_\_\_\_ 0.36-13-7+271 3-3 C. ..... . 8.7 2.88 + 9.0 + 3.0 FL. 1 . 2.4 4..... \_\_\_\_\_ . a.3 C..... ------• • • CB: .... 0.41× 3-7.1.3.1. ----<u>4 b</u> 141 33.6 Ţ. 12..... 0.9913.7 .... C\_\_\_\_\_ . c. 5\_ CBaa 4.6 67 30.3 \_ . . ..... .... .. ..... . . . . . . . . . -----

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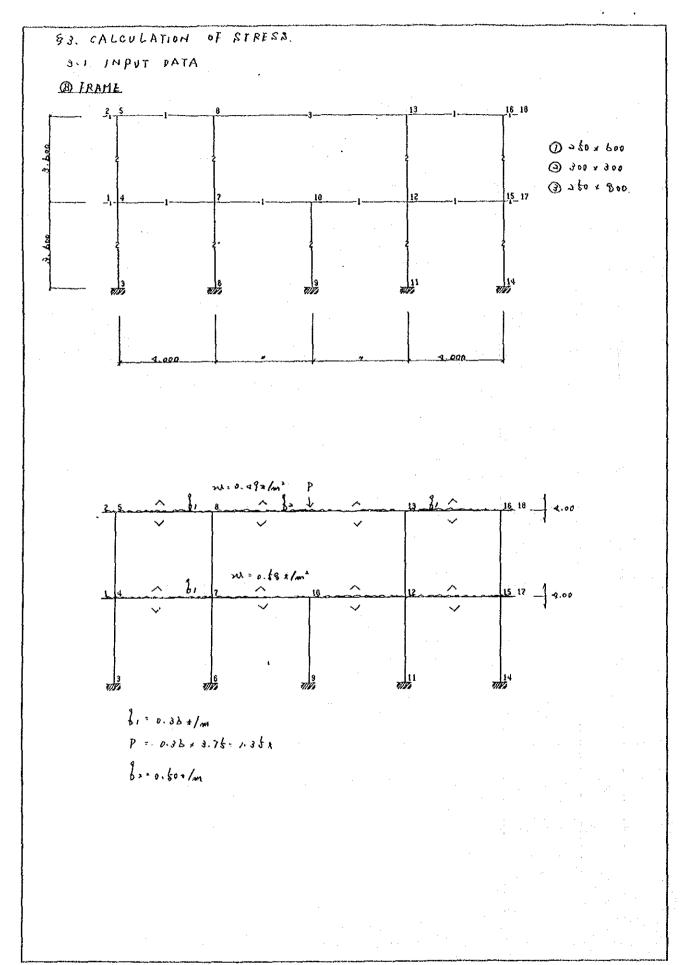
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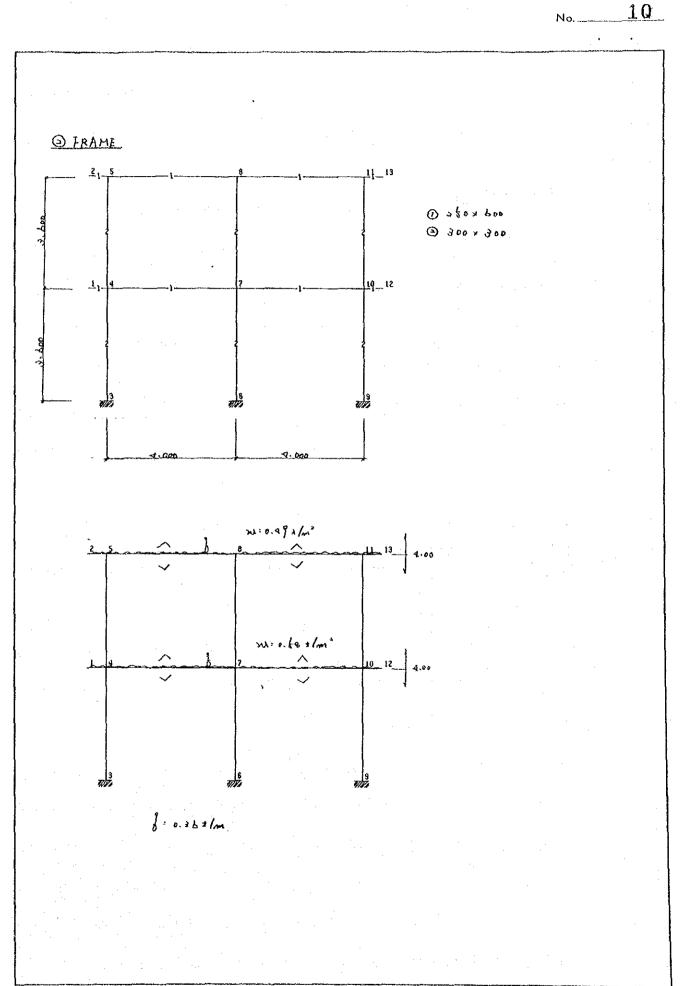
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| NO  | FLOOR            | TITLE                                   | CALCULATION  |   |  | Σ¥<br>(1) |
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|     | -                | £                                       |  |   | 16.9   |           |
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|     |                  | 4                                       | 0.36 + 7.4   | <u></u>                                 |  |           |
|     |                  | ۹                                       |  |   | 13.0   | 26.7      |
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3.2 STRESS PIAGRAM

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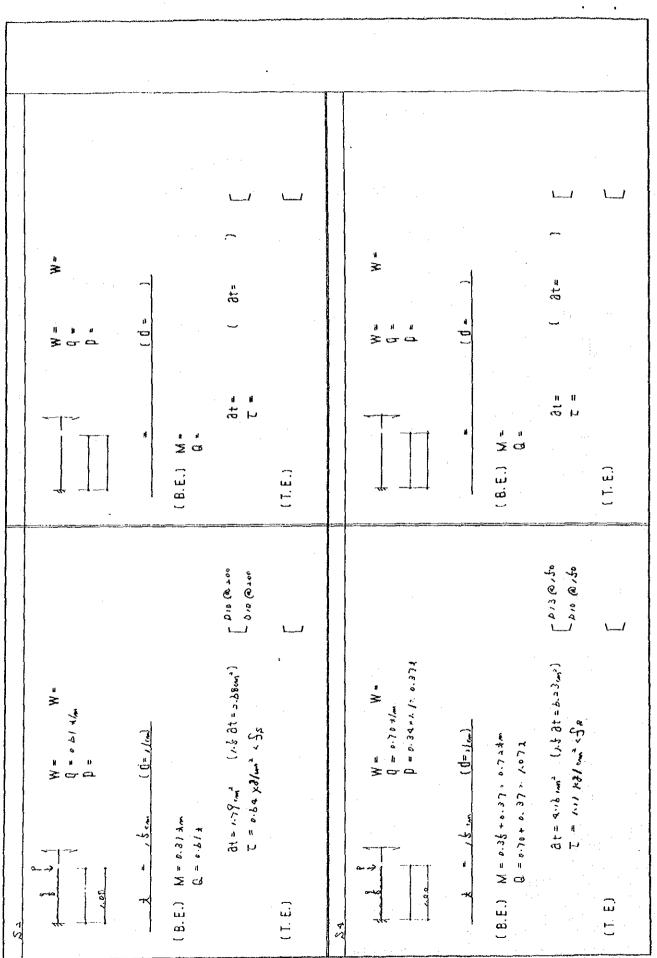
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| 8.         | E             | -25             | <u>o</u> n                              | -28                | <u></u>           |   | •••••                | ¥117           |                           |              | • ••••••• | 4.94                                   |  | 3.0/                                   | 0.20        | <u> </u>                              |
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| 81         | <u> </u>      |                 | · <b>••</b> ·                           | ·                  |                   |   |                      |                |                           |              |           | ··                                     |  |  |             | <u> </u>                              |
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|         |    | b(r=)    | (){i=)     | (10 <sup>4</sup> ۲ж²) | [b]) <sup>1</sup><br>(]05គ*) |  | 4<br>(7)      | AL ,<br>( <i>tra</i> ) | Q        | 1760)<br>(19, 50)                       |         |                 | -at<br>(cd) | (kg/cm <sup>1</sup> ) | 114<br>(i) (in) | - <u>χ</u> Ση Φ                          |
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|         |    |          |            |                       | :<br>                        |  |               |                        |          | · · · · · · · · · · · · · · · · · · ·   | · · · · |                 |             |                       |                 | 4-219                                    |
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|         |    |          |            |                       |                              | $\frac{T_{1}}{T_{2}}$                      |               | -                      |          |   |         |                 |             |                       |                 |  |
|         | -  |          |            |                       |                              | <u>!-</u><br>  ].<br>                      | {             |                        |          |   | •       |                 |             | . <b> </b>            |                 |  |
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|         | Y  |          |            |                       |                              |  | {             |                        |          |   |         |                 |             |                       |                 |  |
|         |    |          |            |                       |                              | T.   |               |                        |          |   |         |                 |             |                       |                 |  |
| 2.      |    |          |            |                       |                              | I, .                                       |               |                        |          |   |         |                 |             |                       |                 |  |
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| <u>ر</u> |  |   | . <u> </u>                         |          |                    |
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|          |  | At<br>2.85<br>1.90<br>3.25<br>2.17              | 3.25<br>2.17<br>3.66<br>2.44       |          |                    |
| ļ        |  |   |                                    |          |                    |
| ]        |  | M<br>0.36<br>0.24<br>0.25                       | 0.46<br>0.31<br>0.31<br>0.31       |          |                    |
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|          |  | BAR   | BAR<br>BAR                         |          | : · · · ·          |
|          |  | t <u>PLACE</u><br>12.0 MAIN BAR X<br>MAIN BAR Y | 13.0 MAIN BAR X<br>Main Bar Y      |          |                    |
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|          |  | 539<br>539                                      | 692                                |          |                    |
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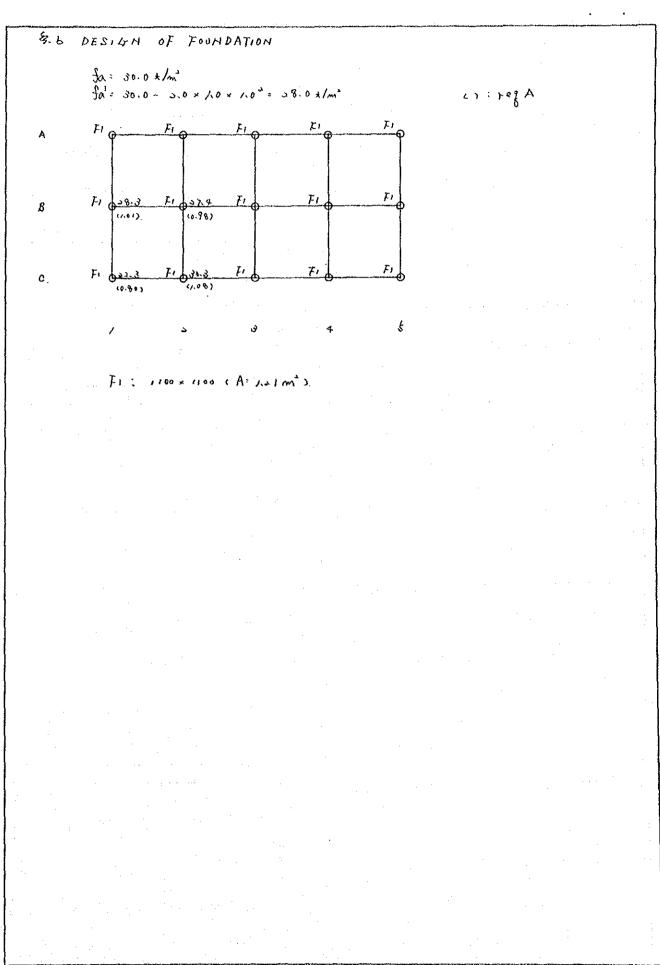


コクヨーコピー15D (52×36)

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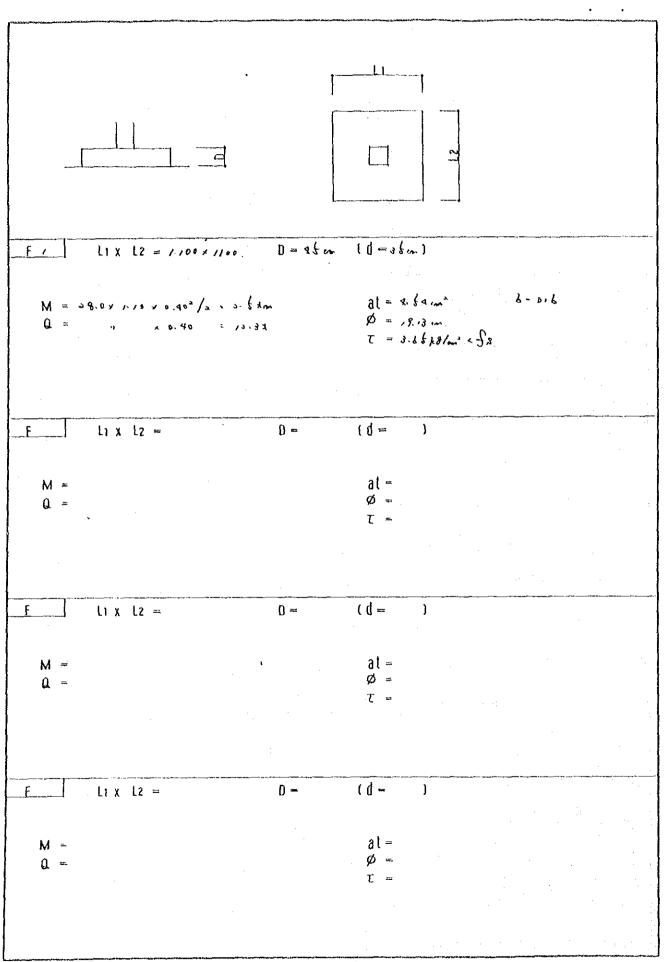
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4.4.3 Gate Control House

§ .1 ASSUMED LOAD

| TITLE               | MATERIAL            | T  | TICK.                 | WEIGHT                | · · · ·         | DL  | LL      | TL      | NOTE     |
|---------------------|---------------------|--|-----------------------|-----------------------|-----------------|---|---------|---------|----------|
|                     |                     | (t/m3)                                   |                       | (kg/m2)               |                 | (kg/m2)   | (kg/m2) | (kg/m2) |          |
|                     | WATER PROOFING      |  | 2.0                   | 10<br>40              | TO<br>FLOOR     |   | 180     | 540     |          |
|                     | SLAB                |  | 12.0                  | 1288                  | TO              |   |         |         |          |
| ROOP                | CBILING             |  | - 11 - 12 -<br>12 - 1 | si ii 20              | BEAM<br>TO      | 360   | 180     | 540     |          |
|                     |                     | - 12-14<br>- 12-14<br>- 12-14<br>- 12-14 |                       | 42 (1)<br>1           | PRAME           | 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -<br>1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -<br>1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - | 190     | 490     | · .      |
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| DEAD LOAD           | OF GIRDER, COL      | UMN, WALL                                |                       |                       |                 |   |         |         |          |
|                     |                     |  | ÷                     |                       |                 |   |         |         |          |
| _                   | •••                 |  |                       |                       | · · · ·         |   |         |         |          |
| <pre>① GIRDER</pre> | , BEAM              |  | · .                   |                       | • •             |   |         |         |          |
|                     | NO B                | <u>D</u>                                 |                       | FINIS                 |                 |   |         |         |          |
| 1.<br>1.            | 25.0                | 60.0                                     | 21<br>, ; .1          | 98.<br>901 -          | 63<br>· · · · · | 360   |         |         |          |
| 2 COLUMN            |                     |  |                       |                       |                 | an se i   |         |         |          |
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| 5.                  |                     | 1  |                       |                       |                 |   |         |         |          |
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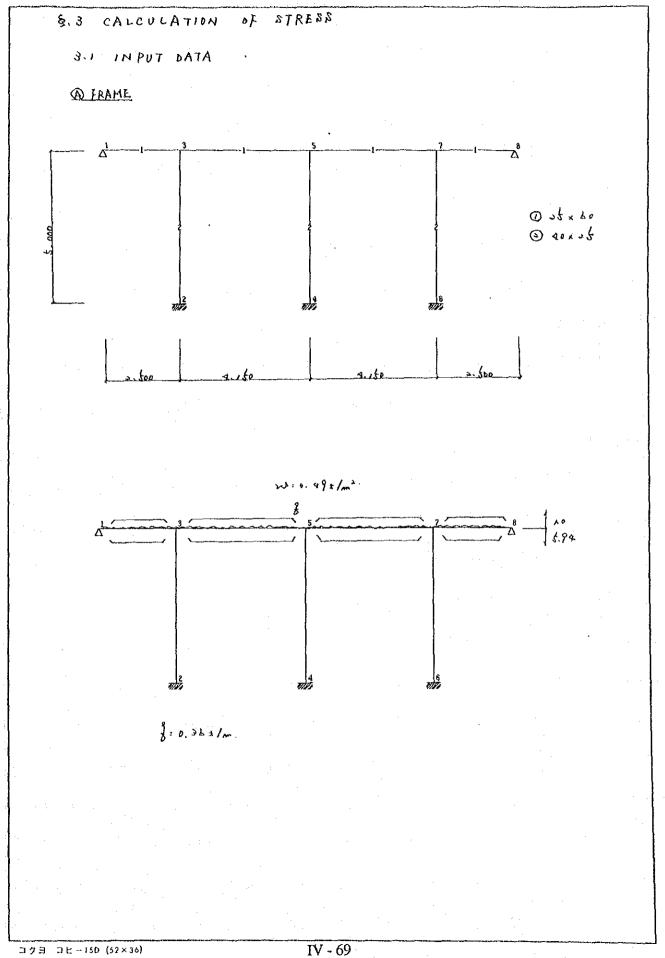
|       |       | ALCULAT                                | ION OF AXIAL FORCE OF COLUMNS  |            |   |           |
|-------|-------|--|--|------------|---|-----------|
|       | FLOOR |  | CALCULATION  | •          | . W<br>. (L)                            | Σ#<br>( ι |
| A-1   | 1.    | Roof                                   | 5.39×3.326×3.07  | 5.0        |   |           |
|       |       | <u>B</u>                               | 0.36x (3.076+3.77)   | <u></u>    |   |           |
|       |       | 0                                      |  | 0.8        |   |           |
|       |       | XY.20                                  | 0.31 × \$ 0/2<br>0.59 × 3.075 × \$.0/2   | -9.5       | 12.4                                    |           |
|       | Ē     | c                                      |  | 0.8        |   |           |
|       |       | wie 0                                  |  | 9.4        | 5-3                                     | 17.7      |
|       |       |  |  | -          |   |           |
| 1 - 2 | 1     | Reof                                   | 0.49 + 3.16+3.17   | <u> </u>   |   |           |
|       |       | <u></u>                                | 0.36x (3.90+2.77)  | 3.4        |   |           |
| !     |       | <u>C</u>                               |  | 0.8        |   |           |
|       |       | W20                                    | 0.58× 3.90× 5.0/2  | \$.7       | 15-1                                    |           |
|       | F     | c                                      |  | 0.8        |   |           |
|       |       | W20                                    | · · · · · · · · · · · · · · · · · · ·  | <u>+ 7</u> | 5.5                                     | -1.6      |
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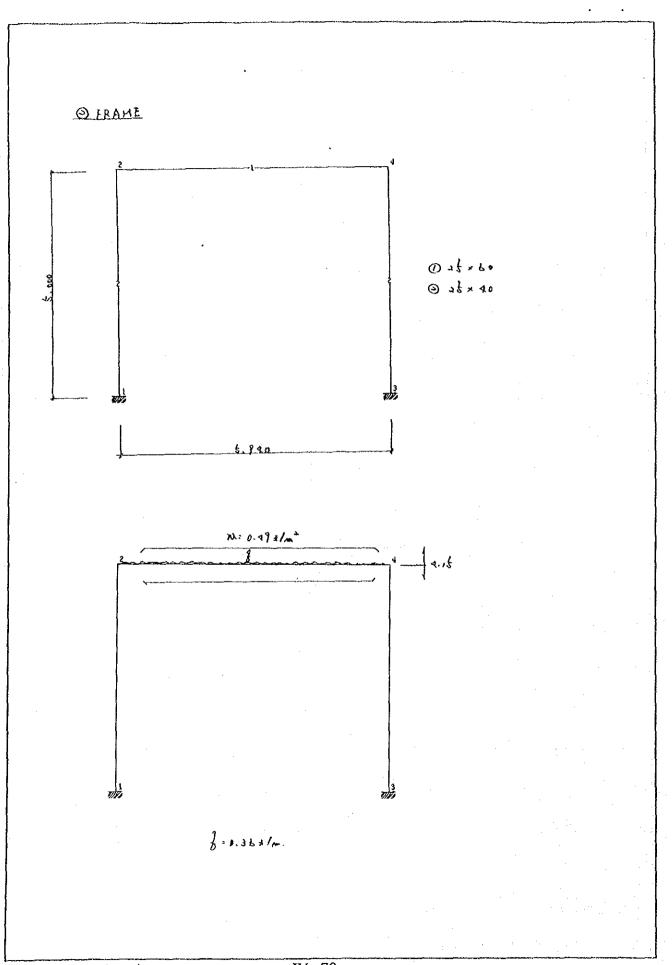
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# No. 21





No. <u>22</u>



## No. \_\_\_\_\_

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## 3.2 STRESS DIAGRAM

<u>© IRAME</u>

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|             | ( 0.0)          | ( 0.0)          | ( 0.0)        |
|             | 0.0             | 0.0             | 0.0           |
|             |                 | ₹ 0,0)<br>0.0   | ( 0.0)<br>0.0 |
|             |                 |                 |               |

<u>O IRAME</u>

| <b>~</b> ~~ | 1.5    | -1.5      |        |
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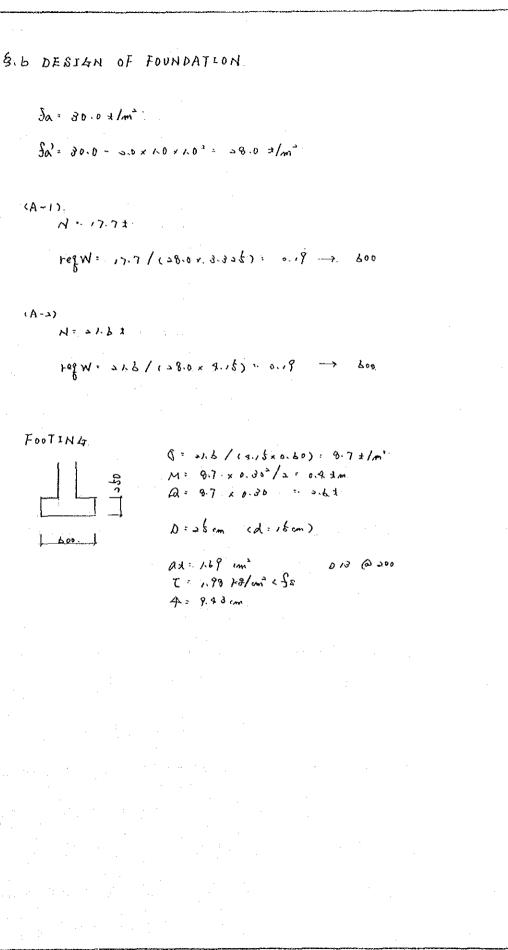
|  | <u> </u>    |           | DER        |   | 1            | M      | ( <i>lm</i> )                           | [ <u></u>   | - <u>(    </u><br>4  | (1)          | - 14A                                   | IN BA   | Q     | CT I    | RUP          |  |
|--|-------------|-----------|------------|---|--------------|--------|---|-------------|--|--------------|---|---|-------|---------|--------------|--|
|  | ]           |           | SECT10     |   |              | l      | f                                       | ןו          |  |              | C MA                                    | IN 08   | n     | يبافرا  |              |  |
| NO   | PLACE       | 8<br>(cm) | (CH)       | (ča)                                      | L.E.         | R      |   | <u>,</u> 1. | E  | T            | (A /el)                                 |   | (CA)  | (19/01) | Pw           | TOP BAR                                |
|  | FUNCE       | - 61      | sd1        | 5   |              |        | · • • · · · · · · · · · · · · · · · · · |             | тъ, ст   |              |   | ul.   | ዋን    | A .     | 11 pt        | BOTTOM                                 |
| $(4^{\circ})$                              | 1.1         |           | (10 4)     |   | 1.8          | К,     | ) <u>)</u> ( (                          | Qu          | 11,<br>11,   | () u         | 1                                       | (64)  | (EM)  | Δ.      | 4r           | BAR                                    |
| <b>B</b> 8/                                |             | 35        | 60         | 64  | 1.t          |        |   | 5.0         |  |              | 1                                       | 176   |       | 4.23    | (            | 3 0.6                                  |
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|  | £.          |           |            |   |              | ·      | ••••••                                  |             |  | . <b></b>    |   |   | *     |         |              | 3                                      |
|  |             |           |            |   |              |        |   | ······      | •  | •            |   |   | ,     |         |              | 3                                      |
|  | _£_         |           |            |   | _ <u>2.6</u> |        |   |             |  | ;            |   | 2.29  | ;<br> | 0100    | 300          | \$                                     |
|  |             |           |            |   |              |        |   |             |  |              | - 11                                    |   |       |         |              | ······                                 |
|  | E           |           |            |   |              |        |   |             |  |              |   |   |       |         |              |  |
| ni anna an a |             |           |            | 1.  |              |        | a Deficienta de la                      | 3.4         |  |              |   | 2.35  |       |         |              | 3 - N/6                                |
| 81   |             | <u></u>   | <u>_60</u> | <u>.</u><br><u></u><br><u></u><br><u></u> | 2.0          |        |   | . <u> </u>  |  | ********     |   | - <u>A. 19</u> -19-19-19-19-19-19-19-19-19-19-19-19-19- |       | 3.6.3.  | , <u> </u>   |  |
|  | <u> </u>    |           |            |   | · ·          | • •~~~ |   |             |  |              |   |   |       |         |              | .3                                     |
|  | ·           |           |            | <br>                                      |              |        |   |             |  |              |   |   |       |         | . <b>-</b> • | 3                                      |
|  |             |           | 1          |   | 1.2          |        |   |             |  |              |   | 191   |       | 0.00    | 200          | 3                                      |
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| <u></u> }                                  | E           |           |            |   |              |        |   |             |  |              |   |   |       |         |              | ······································ |
| <u> </u>                                   |             | 1         |            |   | ·            |        |   |             |  | •• ••• ••• • |   | ·   |       |         |              | ······ ···· ···· ······                |
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|  | C           |           |            |   |              |        |   |             |  |              |   |   |       |         |              |  |
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|  | . C .       | •••       |            |   |              |        |   | 1           |  |              | 1.                                      |   |       |         |              |  |
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|  | <u>-</u>    |           |            | . Linnar                                  |              |        |   | •           |  | · [          |   |   |       | -       | •            | ·                                      |
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|  | I           | 1         | 1          |   | l            |        |   | A ALLAN     | <b>1</b>   | <b>.</b>     |   |   |       | . 1     | - ا          | I                                      |

| NO   |   |                  | SEC                                     | TION                                      |   |                  | ST P                              | ESS        |                       | L N           | AIN                                    | BAR                                    |             | но             | 90P            | Y<br>4 []           |
|--|---|------------------|---|---|---|------------------|-----------------------------------|------------|-----------------------|---------------|--|--|-------------|----------------|----------------|---------------------|
|  |   | Ն ( <i>ո</i> .ա) | і)( <i>г</i> я)                         | հք)<br>(10 <sup>1</sup> 2# <sup>2</sup> ) | hD <sup>4</sup><br>(10 <sup>5</sup> cm <sup>2</sup> ) |                  | (1) <sup>*</sup>                  | <b>М</b> , | Q                     | 1760          | M/bD*<br>(ky/cd)                       | $\mathbf{P}_t$                         | al<br>(cil) | r<br>(ka /cm²) | нф<br>(4) (т)  |                     |
| <u>C</u> 1_                                  |   |                  |   |   |   | <u>`</u><br>     |                                   |            |                       |               |  |  |             |                |                | 1 7, 2014           |
| - J  | x |                  |   |   |   | Е                | 1 Mit 1018 1 1000                 |            |                       |               |  |  |             | 1              |                |                     |
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|  | Y |                  |   |   |   | E                |                                   |            |                       |               |  |  |             |                |                | b sd                |
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| <u>c                                    </u> |   |                  | ·- ·· · · · · · · · · · · · · · · · · · |   |   |                  | •                                 |            |                       |               | ·                                      |  | 0           | 0.54           | Q108           |                     |
|  | x |                  |   | į   |   | "Е               |                                   |            |                       |               | · •··································· | · · · · · · · · · · · · · · · · · · ·  |             |                |                |                     |
|  |   |                  |   |   |   | Т.<br>Т.         | •· •·· •                          |            |                       |               |  | ·                                      |             |                |                |                     |
|  |   |                  |   |   | •••   | <u>-</u>         |                                   |            |                       |               | ·                                      |  |             | ·              | ·· <b>····</b> |                     |
|  | Y |                  |   |   |   | E                |                                   |            |                       | ·             |  |  |             |                |                |                     |
| l  |   |                  |   |   |   |                  |                                   |            | · · ··                |               | ····-                                  | · · · · ·                              |             |                |                | · .                 |
| C  | • | • •              | • • •                                   | *****                                     |   | $\frac{T_2}{L}$  | •                                 |            | <u></u>               |               |  | •••••                                  |             |                |                |                     |
| ĺ  | x |                  |   |   | :   | E                | • • • • • •                       |            |                       |               |  |  |             |                |                |                     |
| ĺ  |   |                  |   |   |   | T1<br><br>T1     |                                   |            |                       | ·             |  |  |             |                | · · .          |                     |
|  |   |                  | ·                                       | •   |   | 1.               | •···                              |            | •                     | *** ****      | •                                      | ·····                                  | <u>-</u>    |                | · ·            |                     |
|  | Y |                  |   |   |   | Е                |                                   |            |                       |               |  |  |             |                |                | ų                   |
|  |   |                  |   |   |   | $T_1$            | ·<br>· · · <del>-</del> · · · · · |            |                       |               |  |  |             |                |                |                     |
|  |   | ·                | ••••                                    |   | •••••••   | <u> </u>         |                                   |            |                       |               |  |  |             |                | •••••••        | · · · · · · · · · · |
|  | x |                  |   |   |   | E                |                                   |            |                       | · · · · · · · |  | •••••••••••••••••••••••••••••••••••••• |             |                |                |                     |
|  |   |                  |   |   |   | T.               |                                   |            |                       |               |  |  |             |                |                |                     |
|  | • |                  | ·· ····                                 |   |   | Т <u>.</u><br>І. | •                                 |            |                       | . <b>.</b>    | <b></b>                                |  |             |                | ••;            |                     |
| · ·  | γ |                  |   |   |   | L<br>E<br>E      | ·                                 | •, ••••    | · · · · ·             | •             | ••• ••• •                              | ·····                                  |             |                |                |                     |
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|  | Y |                  |   |   |   | L<br>E           |                                   | · · · ·    |                       |               |  | ·· ····                                |             |                |                |                     |
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|  |   | · ••             |   |   | . Series  | <u> </u>         |                                   |            |                       | :             | · · · · · · · · · · · ·                |  |             |                |                |                     |
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|                |  |                              |        |              |        |   |        |     |      |          |    |     |      |      |
|                |  |                              | •      |              |        |   |        |     |      |          |    |     |      |      |
|                | ·  |                              | 4<br>4 |              |        |   |        |     | •    |          |    |     |      |      |
|                |  |                              |        |              |        |   |        |     |      |          |    |     |      |      |
|                |  |                              |        |              |        |   |        |     |      |          |    |     |      |      |
|                | 6200<br>6200<br>8200                               | @200<br>@200<br>@250<br>@250 |        |              |        |   |        |     |      |          |    |     |      |      |
|                | 6666   | 00000                        | -      |              |        |   |        |     |      |          |    |     |      |      |
|                | D13<br>D13<br>D10                                  | DIO<br>DIO<br>DIO            |        |              |        |   |        |     |      |          |    |     |      |      |
|                | At<br>4.39<br>2.93<br>1.99                         | 0.34<br>0.23<br>0.13         |        |              |        |   |        |     |      |          |    |     |      |      |
|                | 23<br>33<br>23<br>23<br>23<br>23<br>23<br>23<br>25 |                              |        |              |        |   |        |     |      |          |    |     |      |      |
|                | 1  |                              |        |              |        |   |        | . · |      |          |    |     |      |      |
|                |  | х×                           |        |              |        |   | ÷ .    |     |      |          |    |     | ·: · |      |
|                | t PLACE<br>12.0 MAIN BAR X<br>MAIN BAR Y           | 12.0 MAIN BAR<br>Main Bar    |        |              |        |   |        |     |      |          |    |     |      |      |
|                | O MAI  | LAM 0.                       |        |              |        |   |        |     |      |          |    |     | :    |      |
|                | 19<br>17   | 12.                          |        |              |        |   |        |     |      |          |    |     |      |      |
|                | NO   | त ज                          |        |              |        |   |        |     |      | •        |    |     |      |      |
|                |  | Ð                            |        |              |        |   |        |     |      |          |    |     | •    |      |
| •              | 511<br>511   | 518                          |        |              |        |   |        |     |      |          |    |     |      |      |
|                | 11.27  | 2.62                         |        |              |        |   |        |     |      |          |    |     |      |      |
|                | LV<br>594  | 665                          |        |              |        |   |        |     |      |          |    |     |      |      |
|                | 1<br>390<br>390                                    | 100                          |        |              |        |   |        |     |      |          |    |     |      |      |
|                | 180 TL   | 180                          |        |              |        |   |        | • . |      |          |    |     |      |      |
|                | 80 TI  | 50                           |        |              |        |   |        | • • |      |          |    |     |      |      |
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| OF SL          | NAME<br>ROOF                                       | ROOF                         |        |              |        |   |        |     |      |          |    |     | ÷.,  |      |
| DESIGN OF SLAB |  | 24                           |        |              | ·      |   |        | •   |      |          |    | · · |      |      |
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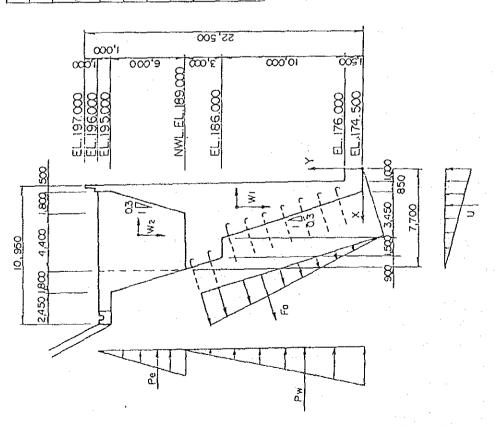
27



|  | (m.1) HM   |                                |             | 508.104        | 192.023        |          |  |       | 700.128     | = 1.87 > 1.5  |
|--|------------|--------------------------------|-------------|----------------|----------------|----------|--|-------|-------------|---|
|  | Mv (t.m)   | 401.645                        | 363.419     |                |                | -143.284 |  |       | 621.779     |   |
|  | ү (m)<br>У |                                |             | 4.833          | 16.833         |          |  |       |             | (i) (1.5m pitch)<br>(i) (1.5m pitch)<br>(i)<br>8 (1m)<br>8 (1m)<br>$= 1.005 \times 3.35 + 63.3$<br>116.532<br>$= 1.9065 \times 1.5$<br>$= 23.06 (/m^2 < 100 t/m^2)$<br>icture design.   |
|  | X (m)      | 2.848                          | 4.955       |                |                | 2.567    |  |       |             | (t) (1.5m pitch)<br>2 (t)<br>2 (t)<br>3 (t)<br>08 (t.m)<br>158.545 + 20 x 3<br>116.532<br>116.532<br>116.532<br>= 1.906> 1.5<br>= 23.06 t/m <sup>2</sup> <<br>ructure design.   |
| TURE   | H (i)      |                                |             | 105.125        | 11 407         |          |  |       | <br>116.532 | The formula for the form of t     |
| Y STRUC<br>g Case I)   | (i) A      | 141.030                        | 73.340      |                |                | -55.825  |  |       | 158.545     | 2.1.7 1+1<br>2.2.1.7 2.2. |
| PILLWA<br>C, Loadin  |            | ٣١                             | W2          | Pw             | Pe             | D        |  |       |             | bree of Ancho<br>ponent:<br>imponent:<br>frs = $\frac{\sum V}{\sum Mt}$<br>fs = $\frac{\sum V}{B}$<br>f = $\frac{\sum V}{B}$<br>tion name, see  |
| STABILITY ANALYSIS OF SPILLWAY STRUCTURE<br>(Side Channel Wall, Section C-C, Loading Case I) | Load       | Body force                     | Earth force | Water pressure | Earth pressure | Uplift   |  |       | Total       |   |
| Table 4.1.1: STABILITY /<br>(Side Channel  | 10,950     | 2.450,1800, 4.400 , 1.800, 500 |             |                | -              |          |  | 000 9 |             | SECTION AND LOADING CONDITION   |

 Table 4.1.2:
 STABILITY ANALYSIS OF SPILLWAY STRUCTURE

 (Side Channel Wall, Section C-C, Loading Case II)



| Load                            |            | V (I)   | H (t)                         | X (m)          | Y (m)  | Mv (t.m) MH (t.m) | Mil (t.m) |
|---------------------------------|------------|---------|-------------------------------|----------------|--------|-------------------|-----------|
| Body force                      | W1.        | 141.030 | 7.052                         | 2.848          | 10.312 | 401.645           | 72.713    |
| Earth force                     | W2         | 73.340  | 3.667                         | 4.955          | 18.213 | 363.419           | 66.788    |
| Water pressure                  | Ρw         |         | 105.125                       |                | 4.833  |                   | 508.104   |
| Earth pressure                  | Pc         |         | 12.469                        |                | 16.833 |                   | 209.889   |
| Uplin                           | 'n         | -55.825 |                               | 2.567          | i      | -143.284          |           |
|                                 |            |         |                               |                |        |                   |           |
|                                 |            |         |                               |                |        |                   |           |
|                                 |            |         |                               |                |        |                   |           |
|                                 |            |         |                               |                |        |                   |           |
| Total                           |            | 158.545 | 128.312                       |                |        | 621.779           | 857.494   |
| ov Docicina Torno of Anchor Bar | a of Anchy |         | En - 66 003 (1) (1 S.n nitch) | 2 (1) (1 5 m - | virch) |                   | •         |

= 1.7 > 1.2 Fa = 66.093 (t) (1.5m pitch) = 1.56 > 1.2 128.312 Ma = 713.008 (t.m) Va = 18.992 (t) Ha = 63.306 (i)621.779 + 713.008 857 494 Max. Resisting Moment of Anchor Bar: Max. Resisting Force of Anchor Bar: НД 11 EM - Horizontal component: - Vertical component: FS≓ Fs = Safety factor for Safety factor overturning: for sliding:

Safety for  $q = \frac{\Sigma V}{B} = \frac{158.545 + 18.992}{7.7} = 23.06 t/m^2 < 100 t/m^2$ 

Note: As for Section name, see Figures of spillway structure design.

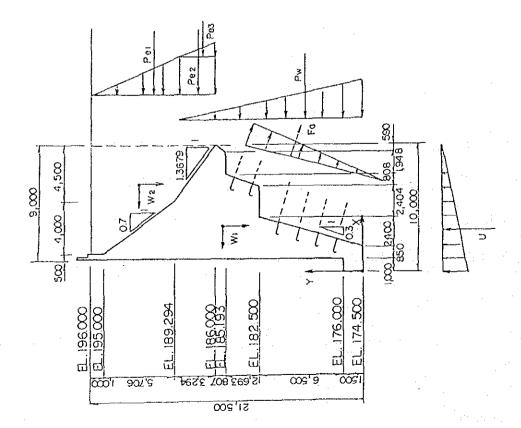
SECTION AND LOADING CONDITION

| ε<br>σ  |   |  | N U N  | ФИ  | (m) X  | (m) /                          | Mu /r m  | Var 1 IV    |
|---|---|--|--|---|--|--------------------------------|----------|-------------|
| 500 4,000 L 4,500                                     | Body force  | W1   | 187.773  |   | 3.526  |                                | 662.103  |             |
|   | Earth force   | W2   | 84.342   |   | 6.763  |                                | 570.370  |             |
|   | Water pressure  | Pw   |  | 105.125   |  | 4.833                          |          | 508.104     |
| 20  | Earth pressure  | Pel  |  | 12.523  |  | 16.833                         |          | 210.802     |
| W2  | Earth pressure  | Pe2  |  | 2.496   | 1  | 13.000                         |          | 32.451      |
| 1.3679  | Earth pressure  | Pe3  |  | 010.1   |  | 12.500                         |          | 13.373      |
|   | Uplift  |  | -72.500  |   | 3.333  |                                | -241.667 |             |
|   |   |  |  |   |  |                                |          |             |
|   |   |  |  |   |  |                                |          | -           |
|   | Toul  |  | 199.615  | 121.214   |  |                                | 990.807  | 764.730     |
| × Fo  | <ul> <li>Max. Resisting Force of Anchor Bar:</li> <li>Vertical component:</li> <li>Horizontal component:</li> <li>Max. Resisting Moment of Anchor Bar:</li> </ul> | : of Ancho.<br>.cnt:<br>oonent:<br>.ent of Anc |  | Fa = 71.583 (t) (1.0)<br>Va = 20.569 (t)<br>Ha = 68.564 (t)<br>Ma = 535.917 (t.m) | Fa = 71.583 (t) (1.0m pitch)<br>Va = 20.569 (t)<br>Ha = 68.564 (t)<br>Ma = 535.917 (1.m) | pitch)                         |          |             |
| 1,000 <u>6,400 2,400 / 1948</u> 590<br>850 10,000 608 | Safety factor Fs = for sliding:   |  | $\frac{\mathbf{f} \cdot \mathbf{\Sigma} \mathbf{V} + \tau \cdot \mathbf{A} + \mathbf{H}_{a}}{\mathbf{\Sigma} \mathbf{H}} = \frac{0.55 \times 199.615 + 20 \times 6.202 + 68.564}{121.214}$ | a <u>0.55 x</u>   | 1 <u>99.615 + 20 x</u><br>121.214  | 20 x 6.202<br>214              | + 68.564 | = 2.5 > 1.5 |
|   | Safety factor for Fs = overturning:   | = ΣMr<br>ΣMi                                   | = <u>990.8</u>   | 990.807+ 535.917<br>764.730   | <u>7</u> = 2.00> 1.5   | <ul><li>1.5</li></ul>          |          |             |
| <b></b>   | Safety for<br>bearing: q  | 2 2  | = 199.61   | <u>199.615 + 20.569</u><br>10.0   |  | $= 22.0 \ t/m^2 < 100 \ t/m^2$ | /m2      |             |
| SECTION AND LOADING CONDITION                         | Note: As for Section name, see Figures of spillway structure design.  | t name, see                                    | lo sangiT :  | spillway st   | rncture de   | iign.                          |          |             |

STABILITY ANALYSIS OF SPILLWAY STRUCTURE (Transition Wall, Section G-G, Loading Case I)

Table 4.1.3:

Note: As for Section name, see Figures of spillway structure design.



| Load               |          | V (I)   | (1) H           | X (m) | Y (m)  | Mv (t.m) | MII (1.m) |
|--------------------|----------|---------|-----------------|-------|--------|----------|-----------|
| Body force W1      |          | 187.773 | 9.389           | 3.526 | 10.866 | 662.103  | 102.013   |
| Earth force W2     |          | 84.342  | 4.217           | 6.763 | 17.837 | 570.370  | 75.221    |
| Water pressure Pw  |          |         | 105.125         |       | 4.833  |          | 508.104   |
| Earth pressure Pel |          |         | 14.025          |       | 16.833 |          | 236.091   |
| Earth pressure Pe2 |          |         | 2.796           |       | 13.000 |          | 36.344    |
| Earth pressure Pe3 |          |         | 1.198           | 1     | 12.500 |          | 14.977    |
| Uplift U           | <u> </u> | -72.500 |                 | 3.333 |        | -241.667 |           |
|                    |          |         |                 |       |        |          |           |
|                    |          |         |                 |       |        |          |           |
| Total              |          | 199.615 | 199.615 137.091 |       |        | 990.807  | 972.750   |
|                    |          |         |                 |       |        |          |           |

Max. Resisting Force of Anchor Bar: Fa = 71.583 (1) (1.0m pitch) - Vertical component: Va = 20.569 (1) - Horizontal component: Ha = 68.564 (1)

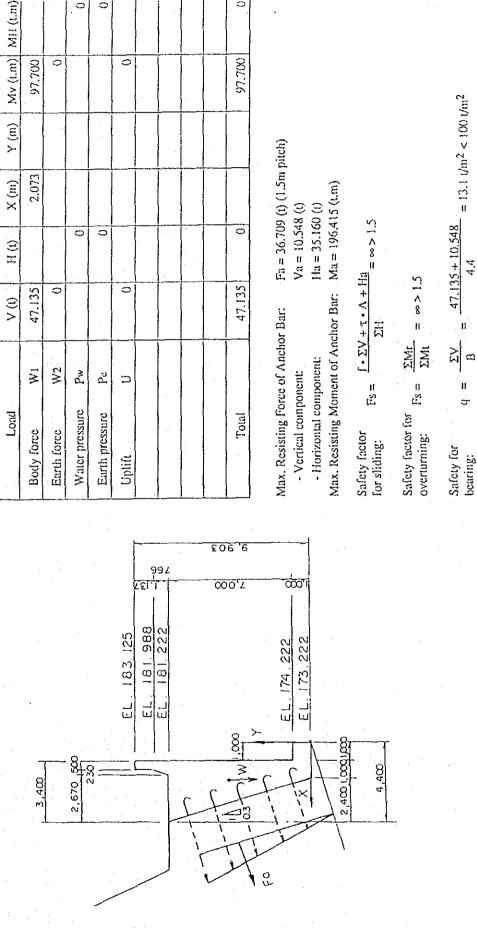
Max. Resisting Moment of Anchor Bar: Ma = 535.917 (t.m)

= 2.2 > 1.2  $\frac{f \cdot \Sigma V + \tau \cdot A + Ha}{2} = \frac{0.55 \times 199.615 + 20 \times 6.202 + 68.564}{2000}$  $\frac{199.615 + 20.569}{100 \text{ } \text{lm}^2} = 22.0 \text{ } \text{lm}^2 < 100 \text{ } \text{lm}^2$ = 1.57 > 1.2 136.750  $\frac{\Sigma Mr}{\Sigma Mt} = \frac{990.807 + 535.917}{972.750}$ 10.0 ΣH 11 ఎ ģ FS = Safety factor for Fs = П σ Safety factor overturning: for sliding: Salciy for bcaring:

Note: As for Section name, see Figures of spillway structure design.

SECTION AND LOADING CONDITION

STABILITY ANALYSIS OF SPILLWAY STRUCTURE (Chuteway Side Wall, Section A-A, Loading Case I) Table 4.1.5:

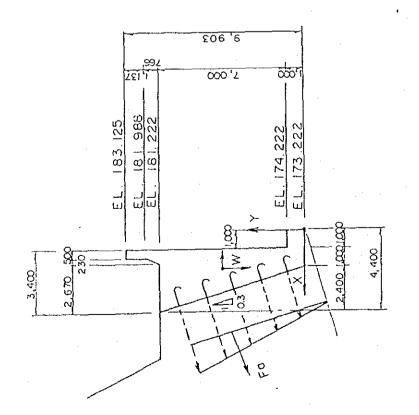


Note: As for Section name, see Figures of spillway structure design.

SECTION AND LOADING CONDITION

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SECTION AND LOADING CONDITION

| Load           | ;  | V (I)  | H (t) | X (m) | Y (m) | Mv (t.m) MH (t.m) | (Im) IIM |
|----------------|----|--------|-------|-------|-------|-------------------|----------|
| Body force     | W1 | 47.135 | 2.357 | 2.073 | 4.733 | 97.700            | 11.153   |
| Earth force    | W2 | 0      |       |       |       | 0                 |          |
| Water pressure | Pw |        | 0     |       |       |                   | 0        |
| Earth pressure | Pe |        | 0     |       |       |                   | 0        |
| Uplifi         | n  | 0      |       |       |       | 0                 |          |
|                |    |        |       |       |       |                   |          |
|                |    |        |       |       |       |                   |          |
|                |    |        |       |       |       |                   |          |
|                |    |        |       |       |       |                   |          |
| Total          |    | 47.135 | 2.357 |       | -     | 97.700            | 11.153   |

Max, Resisting Force of Anchor Bar: Fa = 36.709 (t) (1.5m pitch)
Vertical component: Va = 10.548 (t)
Horizontal component: Ha = 35.160 (t)
Max. Resisting Moment of Anchor Bar: Ma = 196.415 (t.m)

Safety factor Fs =  $\frac{f \cdot \Sigma V + \tau \cdot A + Ha}{\Sigma H} = \frac{0.55 \times 47.135 + 20 \times 2.0 + 35.16}{2.357} = 42.9 > 1.2$ for sliding: Fs =  $\frac{\Sigma Mr}{\Sigma H} = \frac{97.700 + 196.415}{11.153} = 26.37 > 1.2$ 

Safety for  $q = \frac{\Sigma V}{B} = \frac{47.135 + 10.548}{4.4} = 13.11 \text{ (}\text{m}^2 < 100 \text{ (}\text{m}^2)$ 

Note: As for Section name, see Figures of spillway structure design.

|   | (III)<br>WII (L.M.)                              | 203.431                  | 203.431  |  |
|---|--|--------------------------|--|--|
|   | <u> </u>   |                          | 0  |  |
|   | ╞╌┼╌┼╼┼╼╴  |                          | 468  | t/m <sup>2</sup>   |
|   | Y (m)  | 17.833                   | n pitch)<br>+ 20 x 3.92  | 1.5<br>1 <sup>2</sup> < 100<br>itgn.   |
|   | X (m)<br>2.398<br>4.448<br>0.500                 | 1.675                    |  | <u>196</u> = 6.1> 1.5<br>- =24.1 <i>V</i> m <sup>2</sup> < 100 <i>V</i> m <sup>2</sup><br>structure design.  |
| rure<br>se l)   | H (I)  | 11.407                   |  | 468.240 + 773.896<br>203.431<br>140.840+ 20.341<br>6.7<br>ures of spillway stru  |
| Y STRUC   | V (I)<br>104.835<br>59.830<br>8.000              | -31.825                  | 840<br>ar:<br>A + F  | - = <u>468.24</u><br>= <u>140.84</u><br>cc Figures of  |
| SPILLWA<br>ction E-E, I   | W1<br>W2<br>W3                                   |                          | ponent:<br>ponent:<br>ponent:<br>foment of Ar<br>$F_S = \frac{f \cdot \Sigma_1}{F_S}$  | $F_{S} = \frac{\Sigma M r}{\Sigma M t}$ $q = \frac{\Sigma V}{B}$ tition name, se   |
| NAL YSIS OF<br>Side Wall, See   | Load<br>Body force<br>Earth force<br>Water force | Earth pressure<br>Uplift | Total140.84(Max. Resisting Force of Anchor Bar:- Vertical component:- Ilorizontal component:Max. Resisting Moment of Anchor Bar:Safety factor $Fs = f \cdot \Sigma V + \tau \cdot A + for sliding:Fs = \frac{f \cdot \Sigma V + \tau \cdot A + for sliding:$ | Safety factor for $F_{S} = \frac{\Sigma M r}{\Sigma M t} = \frac{468,240 + 773,896}{203,431} = 6.1 > 1.5$<br>overturning: $F_{S} = \frac{\Sigma V}{2} = \frac{140.840 + 20.341}{6.7} = 24.1 /\text{m}^2 < \frac{140.840 + 20.341}{6.7} = 24.1 /\text{m}^2 < \frac{140.840 + 20.341}{6.7} = 24.1 /\text{m}^2 < \frac{140.840 + 20.341}{6.7} = 24.1 /\text{m}^2 < \frac{140.840 + 20.341}{6.7} = 24.1 /\text{m}^2 < \frac{140.840 + 20.341}{6.7} = 24.1 /\text{m}^2 < \frac{140.840 + 20.341}{6.7} = $ |
| Table 4.1.7:       STABILITY ANALYSIS OF SPILLWAY STRUCTURE         (Stillway Basin Side Wall, Section E-E, Loading Case I) |  | EL. 123.000              |  | SECTION AND LOADING CONDITION  |

222.357 343.057 57.620 63.079 MII (Lm) Mv (t.m) 4.000 53.307 468,240  $\mathbf{f} \cdot \mathbf{\Sigma} \mathbf{V} + \mathbf{\tau} \cdot \mathbf{A} + \mathbf{Ha} = \underbrace{0.55 \times 140.840 + 20 \times 3.925 + 67.802}_{\text{constrained}}$ 251.400 266.147 =24.1 t/m<sup>2</sup> < 1()0 t/m<sup>2</sup> 12.034 19.261 17.833 ζ (m) γ Fa = 70.787 (t) (1.5m pitch) 20.702 = 3.62> 1.2 4,448 2.398 0.500 1.675 (m) X Ma = 773.896 (t.m) Va = 20.341 (I) Ha = 67.802 (t)468,240+773,896 2.992 5.242 12.469 140.840+ 20.341 20.702 H (I) 343.057 6.7 140.840 59.830 -31.825 8.000 104.835 (i) N Max. Resisting Moment of Anchor Bar: Max. Resisting Force of Anchor Bar: HΣ 11 İI ΣMr ZMI 2 ц - Horizontal component: W2 W3 WI - Vertical component: 5 Э FS = Es = Ħ c Load Total Safety factor for Earth pressure Water force Body force Earth force Safety factor overturning: for sliding: Safety for bcaring: Uplift 23,500 () () 2.000\_1 EL.112.000 000.11 2000 E ω 000,8 VWL..EL.120000 FL. 123000 134 000 EL. 126000 SECTION AND LOADING CONDITION Pwi 8 2001/02/12012 9,300 Ň 5222,2100\_3,400 1,800, ŝ 50 ເດ O 17w1

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STABILITY ANALYSIS OF SPILLWAY STRUCTURE (Stillway Basin Side Wall, Section E-E, Loading Case II) Table 4.1.8 :

Note: As for Section name, see Figures of spillway structure design.

= 10.81> 1.2

| 9,300                         | Loud   | V (I)   | H (I)                               | X (m)   | Y (m)   | Mv (Lm)  | MII (Lm)    |
|-------------------------------|--|---|-------------------------------------|---|---|----------|-------------|
|                               | Body force W1  | 104.835   |                                     | 2.398   |   | 251.400  |             |
|                               | Earth force W2   | 59.830  |                                     | 4.448   |   | 266.147  |             |
|                               | Water force W3   | 8.000   |                                     | 0.500   | :   | 4.000    |             |
|                               | Earth pressure Pe  |   | 11.407                              |   | 17.833  |          | 203.431     |
|                               | Water pressure Pw1   |   | -45.125                             |   | 3.167   |          | -142.896    |
|                               | Water pressure Pw2   |   | 120.125                             |   | 7.167   |          | 860.896     |
|                               | Upiifi Ul  | -18.288   |                                     | 0.963   |   | -17.602  |             |
|                               | Uplift U2  | -37.006   |                                     | 3.517   |   | -130.139 |             |
|                               | Uplift U3  | -5.775  |                                     | 1.283   |   | -7,411   |             |
| 1 1 1 1 - 1 MML. EL. 120.000  | Total  | 111.596   | 86.407                              | +   |   | 366.395  | 921.431     |
|                               |  |   |                                     |   |   |          |             |
|                               | Max. Resisting Force of Anchor Bar:<br>- Vertical comment:           |   | Fa = 70.787 (t)<br>Va = 20.341 (t)  | Fa = 70.787 (t) (1.5m pitch)<br>Va = 20.341 (t) | aitch)  |          |             |
|                               | - Horizontal component:  | Ha  | Ha = 67.802 (t)                     | e (   |   |          |             |
|                               | Max. Resisting Mornent of Anchor Bar:                                |   | Ma = 773.896 (1.m)                  | Q (1.m)   |   |          |             |
|                               | Safety factor $F_S = \frac{f \cdot \Sigma}{F_S}$                     | $\frac{f \cdot \Sigma V + \tau \cdot \Lambda + Ha}{\Sigma H}$ | = 0.55 × 1                          | 11.596 + 86                                     | <u>0.55 x 111.596 + 20 x 3.925 + 67.802</u><br>86.407 | + 67.802 | = 2.4 > 1.2 |
|                               | Safety factor for $F_{S} = \frac{\Sigma Mr}{\Sigma M_{I}}$           | 11  | <u>366.395 + 773.896</u><br>921.431 | = 1.24 > 1.2                                    | > 1.2   |          |             |
| <b>5</b>                      | Safety for $q_1 = \frac{\Sigma V}{B}$ bearing:                       | $=\frac{111.596}{6}$  | 111.596 + 20.341<br>6.7             | m/) [].e1=                                      | =19.7 \m2 < 100 \m2                                   | 1112     |             |
| SECTION AND LOADING CONDITION | Note: As for Section name, see Figures of spillway structure design. | ce Figures of sp  | illway str                          | ncture des                                      | ign.  |          |             |

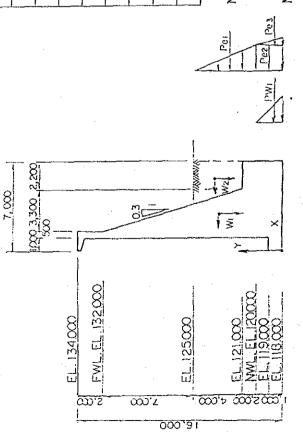
STABILITY ANALYSIS OF SPILLWAY STRUCTURE (Stillway Basin Side Wall, Section E-E, Loading Case III)

Table 4.1.9:

Note: As for Section name, see Figures of spillway structure design.

 Table 4.1.10:
 STABILITY ANALYSIS OF SPILLWAY STRUCTURE

 (Stilling Basin Side Wall, Section I-I, Loading Case I)



| Load           |     | V (i)   | H (I) | X (m) | Y (m) | Mv (Lm) Mii (t.m) | MII (t.m) |
|----------------|-----|---------|-------|-------|-------|-------------------|-----------|
| Body force     | W1  | 105.720 |       | 2.907 |       | 307.276           |           |
| Earth force    | W2  | 22.002  |       | 5.558 |       | 122.285           |           |
| Water pressure | Pw  |         | 2.000 |       | 0.667 |                   | 1.333     |
| Earth pressure | Pel |         | 5.820 |       | 3.667 |                   | 21.340    |
| Earth pressure | Pc2 |         | 1.484 |       | 1.000 |                   | 1.484     |
| Earth pressure | Pe3 |         | 0.593 |       | 0.667 |                   | 0.396     |
| Uplift         | n   | -7.000  | -     | 3.500 |       | -24.500           |           |
|                |     |         | 1     |       |       |                   |           |
|                |     |         |       |       |       |                   |           |
| Total          |     | 120.722 | 9.897 |       |       | 405.061           | 24.553    |
|                |     |         |       |       |       |                   |           |

Max. Resisting Force of Anchor Bar:Fa = 0- Vertical component:Va = 0- Horizontal component:Ha = 0Max. Resisting Moment of Anchor Bar:Ma = 0

Safety factor  $F_{S} = \frac{f \cdot \Sigma V + \tau \cdot \Lambda + Ha}{\Sigma H} = \frac{0.55 \times 120.722 + 20 \times 7.0}{9.897} = 20.9 > 1.5$ for sliding:

⇒

Safety factor for  $F_S = \frac{\Sigma Mr}{\Sigma M_1} = \frac{405.061}{24.553} = 16.5 > 1.5$  overturning:

Safety for  $q = \frac{\Sigma}{B} \left( 1 + \frac{5c}{B} \right) = \frac{120.722}{7.00} \left( 1 + \frac{6 \times 0.348}{7.00} \right) = 22.4, 12.1 \text{ t/m}^2$ 

SECTION AND LOADING CONDITION

G CONDITION Note: As for Section name, see Figures of spillway structure design.

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 Table 4.1.11: STABILITY ANALYSIS OF SPILLWAY STRUCTURE

 (Stilling Basin Side Wall. Section I-I. Loading Case II)

35.342 221.833 270.842 Mv (Lm) MII (Lm) 457.333 6.500 -24.500 142.061 307.276 -269.500 122.285  $\frac{f \cdot \Sigma V + \tau \cdot \Lambda + H_{a}}{2000} = \frac{0.55 \times 53.222 + 20 \times 7.0}{2000} = 4.0 > 1.2$ 2.333 3.667 4.667 ζ(m) Υ  $\frac{2x53.222}{6.015} = 17.7 \ t/m^2 < 100 \ t/m^2$ 3.500 2.333 2.907 5.558 0.500 78.575 (m) X = 3.4 > 1.2 78.575 116.075 60.500 -98.000 H (C) Va = 0Max. Resisting Moment of Anchor Bar: Ma = 0 Ha = 0Fa = 035.342 142.061 53.222 -10.500 -77.000 105.720 22.002 13.000 Ω Λ Max. Resisting Force of Anchor Bar: H, ΣII Ił ΣMr ΣMt 22V B - Horizontal component: Pw2 Pwl W2 W3 Pc2 Pe3 Pel 5 Ň 5 - Vertical component: Fs = 0. II FS = Water pressure Load Water pressure Total Safety factor for Earth pressure Earth pressure Earth pressure Water force Body force Earth force Safety factor overturning: for sliding: Safety for bearing: Uplift Uplifi 55 EL.129.000 IPw1 <u>cm\_3,300\_2,200</u> ŝ 28/2 5 ž g Ś ≻ FWLEL.132.000  $\frac{1}{10000}$ PW2 125.000 EL.131000 EL.121.000 000,811 ц Ш Ž

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Table 4.1.12: STABILITY ANALYSIS OF SPILLWAY STRUCTURE (Stillway Basin Side Wall, Section I-I, Loading Case III)

Note: As for Section name, see Figures of spillway structure design.

| JOW WEIR                            |                    |
|-------------------------------------|--------------------|
| OF OVERFL                           |                    |
| STABILITY ANALYSIS OF OVERFLOW WEIR | (Normal Condition) |
| Table 4.1.13:                       |                    |

| Body force |      |        | Water force | Water pressure |      | Uplift |   | Total      |    | Max. Resisting Porce | <b>3</b> |   | Cuttor Control |
|------------|------|--------|-------------|----------------|------|--------|---|------------|----|----------------------|----------|---|----------------|
| -          |      | •<br>• |             |                |      | 0.4    | M | -<br>-<br> |    | . •••                |          |   |                |
|            | 9.50 |        | T           |                | MW M | W3     |   | - W2       | nd |                      | ^        | Ĺ |                |
|            |      | 0.0    | {           |                |      |        |   | MI -       |    |                      |          |   |                |

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508.104

4.833 16.833

3.90

6.50 8.50

18.40

154.84 86.11 119.60 68.00

5.10

30:36 22.08

W1 W2

W3 Ň × X

1.21 (i)

0.47

0.57

MII (1.m)

Mv (Lm)

χ (m)

X (m)

(I) H

Load

-27.63

1.38

-15.13

Ρw

8.00

-235.13

4.50

-52.25

-262.76

429.12

-15.13

27.80

Fa = 48.18 (1)(1.5mpitch)

of Anchor Bar:

cut of Anchor Bar: Ma = 216.81 (t.m)

 $\frac{f \cdot \Sigma V + \tau \cdot \Lambda + 11a}{v t} = \frac{0.55 \times 27.8 + 20 \times 9.5}{15.12}$ ΣH ES == Safety factor for sliding:

- = 13.6> 1.5

15.13

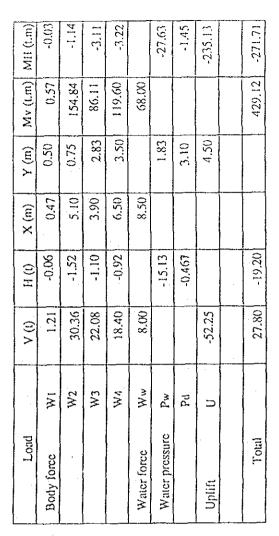
= 2.46> 1.5 = 429.12 + 216.81 262.76 <u>SMr</u>  $F_{\rm S} =$ Safety factor for overturning:

= 8.0 /m2 < 100 /m2 $= \frac{27.80 + 48.18}{0.5}$ 9.5 ୷ଇ н b Safety for bearing:

Note: As for Section name, see Figures of spillway structure design.

Table 4.1.14:

STABILITY ANALYSIS OF OVERFLOW WEIR (Seismic Condition)



Fa = 48.18 (1)(1.5mpitch)Max. Resisting Moment of Anchor Bar: Ma = 216.81 (t.m) Max. Resisting Force of Anchor Bar:

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120

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Fa

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EL. 189. 0

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80 4

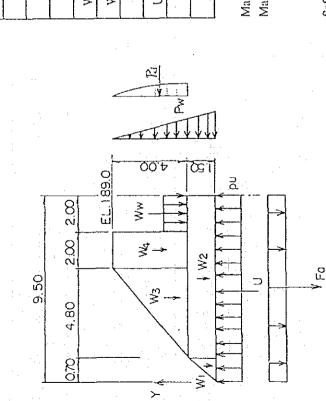
g

9.50

= 10.7> 1.5  $= 8.01/m^2 < 1001/m^2$ 0.55 x 27.8 + 20 x 9.5 - = 2.38> 1.5 19.20 429,12 + 216.81 27.80 + 48.18271.71  $\frac{f \cdot \Sigma V + \tau \cdot \Lambda + Ha}{f} = -$ 9.5 -£Η It 11 **ZMr** 긻 E Safety factor for Fis = ES II n o Safety factor for sliding: overturning: Safety for bearing:

Note: As for Section name, see Figures of spillway structure design.

Table 4.1.15: STABILITY ANALYSIS OF OVERFLOW WEIR (After the Flood (P.M.F))



Max. Resisting Force of Anchor Bar: Fa = 48.18 (1)(1.5mpitch) Max. Resisting Moment of Anchor Bar: Ma = 216.81 (1.m)

| $= \frac{20 \times 9.5}{15.13} = 12.6 > 1.2$ | $\frac{2+216.81}{455.13} = 1.42 > 1.2$                         |
|--|--|
| T•A<br>EH                                    | $\frac{\Sigma Mr}{\Sigma Mt} = \frac{429.12 + 216.81}{455.13}$ |
| اا<br>بې                                     |  |
| Safety factor<br>for sliding:                | Safety factor for<br>overturning:                              |

Table 4.1.16 : STRESS ANALYSIS OF REINFORCED CONCRETE (Spillway Side Wall, Section C - C)

(kg/cm2)|(kg/cm2) 2.426 0.518 0.625 2.426 Q/bd M'/bd^2 0.701 0.866 0.866 0.55 N+W=W 16.98 (t m) 16.98 33.94 26.6 p/,p (cm) σ (mo) 220 220 140 140 Sectional dimension σ (cm) Þ (cm) 150 150 230 230 c (m) (cm) 100 100 100 007 zΞ 33.96 11.40 13.75 33.96 σΞ Internal force 16.98 26.60 33.94 (t.m) 16.98 Σ Spot Direction Cond-| Member EL.189 EL.189 Toe Toe Seis. Seis. Nor Nor. Load Ìon

|         |         | Sectional area of reinforcing | orcing bar |        | = du             | Coeff. 1 | Coeff. from Nomogram | logram | Stre     | Stress (kg/cm2)  | m2)   |
|---------|---------|-------------------------------|------------|--------|------------------|----------|----------------------|--------|----------|------------------|-------|
| I=M/N+U | f/d     | AS                            | As'        | As'/As | As'/As n.As/bd C | 0        | s.<br>S              | Z      | SIGc=    | SIGs=            | Tau=  |
|         | :       | (cm2)                         | (cm2)      |        | · (              |          |                      |        | CM'/bd^2 | CM/bd^2 nSM/bd^2 | PQ/DZ |
|         | .       | D19@200 = 14.33               |            |        | 0.010 15.9       | 15.9     | 105                  | 1.05   | 8.7      | 366              | 0.5   |
|         | .  <br> | D19@200 = 14.33               |            |        | 0.010 15.9       | 15.9     | 105                  | 1.05   | 11.1     | 1104             | 0.7   |
|         |         | D19@200 = 14.33               |            |        | 0.015 13.2       | 13.2     | 70.3                 | 1.06   | 11.4     | 914              | 2.6   |
|         |         | D19@200 = 14.33               |            |        | 0.015            | 13.2     | 70.3                 | 1.06   | 11.4     | 914              | 2.6   |
|         |         |                               |            |        |                  |          | · .                  |        |          |                  |       |
|         |         |                               |            |        |                  |          |                      |        |          |                  |       |
|         |         |                               |            |        |                  |          |                      |        |          |                  |       |

Allowable stress : SIGca=60 & 90(\*) kg/cm2, SIGsa = 1,800 & 2,700(\*) kg/cm2, TAUa = 8 &12(\*) kg/cm2 · : Allowable stresses marked with (\*) are applied for the sesmic and flood conditions. n=Es/Ec=15,

Table 4.1.17 : STRESS ANALYSIS OF REINFORCED CONCRETE ( Spillway Side Wall, Section G - G & A - A )

(kg/cm2) (kg/cm2) 1.189 Q/bd 0.015 M'=M+Nu M'/bd^2 0.839 0.660 16.45 (t.m) 5.35 p/.p (cm) σ (cm) 140 06 Sectional dimension σ (cm) ∍ ч (ms) 150 100 (cm) 100 1 0:0 م zΞ 32.90 10.70 σΞ Internal force 16.45 (t.m) 5.35 Σ Spot Direction A--A С О Cond- Member Toe Toe Seis Seis. Nor. Load tion

|         |     | Sectional area of reinforcing bar | inforcing bar |        | = du             | Coell. | Coeff. Irom Nomogram | nogram | Stre    | ess (kg/ci             | n2)   |
|---------|-----|-----------------------------------|---------------|--------|------------------|--------|----------------------|--------|---------|------------------------|-------|
| f=M/N+u | f/d | As                                | Ast           | As'/As | As'/As n.As/bd C | U      | S                    | 2      | SIGc=   | SIGS= 18               | Tau=  |
|         | - : | (cm2)                             | (cm2)         |        |                  |        |                      |        | CM/bd^2 | CM/bd^2 nSM/bd^2 ZO/bd | ZO/bd |
|         |     |                                   |               |        |                  |        |                      |        |         |                        |       |
|         |     | D19@200=14.33                     |               |        | 0.015            | 13.2   | 70.3                 | 1.06   | 11.0    | 885                    | 2.5   |
|         | -   | D19@200=14.33                     | -             |        | 0.024            | 10.9   | 0.024 10.9 44.6 1.07 | 1.07   | 7.2     | 442                    | 1.3   |
|         |     |                                   |               |        |                  |        |                      |        |         |                        |       |
|         |     |                                   |               |        |                  |        |                      | 1      |         |                        |       |
|         |     |                                   |               |        |                  |        |                      |        |         |                        |       |
|         |     |                                   |               |        |                  |        |                      |        |         |                        |       |

n=Es/Ec=15, Allowable stress : SIGca=60 & 90(\*) kg/cm2, SIGsa = 1,800 & 2,700(\*) kg/cm2, TAUa = 8 &12(\*) kg/cm2 · : Allowable stresses marked with (\*) are applied for the sesmic and flood conditions.

1.686 (Kg/cm2) 0.518 1.786 Tau≕ 0.627 ZQ/bd pq/p 0.5 0 ъ. 1 8 0.7 Stress (kg/cm2) nSM'/bd^2 M=M+Nu M'/bd^2 (kg/cm2) SIGs= 0.638 0.602 1117 634 866 673 0.55 0.71 CM'/bd^2 SIGC= 34.34 11.8 -1-0 12.5 26.6 7.9 8.7 α. 4 (t.m) 1.06 1.06 1.05 1 05 Coeff. from Nomogram p/,p Ν 70.3 70.3 105 1.05 (cm) S 15.9 15.9 13.2 13.2 220 220 140 140 (cm) Sectional dimension  $\circ$ σ As'/As n.As/bd 0.015 0.015 = du (cm) 0.01 0.01 Table 4.1.18 : STRESS ANALYSIS OF REINFORCED CONCRETE ∍ 230 230 150 150 (cm) ء Spillway Side Wall, Section E-E) 100 100 100 100 a (m) (cm2) ,s∖ zΞ ı ı , Sectional area of reinforcing bar 25.00 23.60 11.40 13.79 σΞ Internal force 11.80 26.60 12.50 34.34 (t. m) Z D19@200=14.33 D19@200=14.33 D19@200=14.33 D19@200=14.33 (cm2)-Spot Direc-As ion f/d Flood EL. 126.00 Seis. |EL.126.00 Cond-| Member n=Es/Ec=15, Toe Toe =M/N+u Flood Nor.8 Nor.& Seis. Load ю

Aliowable stress : SIGca=60 & 90(\*) kg/cm2, SIGsa = 1,800 & 2,700(\*) kg/cm2, TAUa = 8 &12(\*) kg/cm2 \* : Allowable stresses marked with (\*) are applied for the sesmic and flood conditions.

 Table 4.1.19 : STRESS ANALYSIS OF REINFORCED CONCRETE

 ( Spiilway Side Wall. Section 1 - L(1) )

| Load         |                |          |       | Inte           | Internal force | ce             |       |      | Sectior | Sectional dimension | nsion  |                      |        |         |                   |         |
|--------------|----------------|----------|-------|----------------|----------------|----------------|-------|------|---------|---------------------|--------|----------------------|--------|---------|-------------------|---------|
| Cond- Member | tember         |          | Spot  | Spot Direc-    | Σ              | σ              | z     | a    | 4       | n                   | P      | 5                    | d'/d   | M'=M+N∪ | M'/bd^2           | Q/bd    |
| tion         |                |          |       | tion           | (t.m)          | (1)            | (1)   | (cm) | (cm)    | (cm)                | (cm)   | (cm)                 | :      | (t.m)   | (kg/cm2) (kg/cm2) | kg/cm2) |
| Nor. El      | Nor. EL.121.0  | н у<br>1 | Back  |                | 4.96           | 3.72           |       | 100  | 380     |                     | 370    |                      |        | 4.96    | 0.036             | 0.101   |
| Seis. El     | Seis. EL.121.0 |          | Back  |                | 23.60          | 7.46           | 1     | 100  | 380     |                     | 370    |                      |        | 23.6    | 0.172             | 0.202   |
| Flood El     | Flood EL.121.0 |          | Front |                | 134.11         | 26.71          | •     | 100  | 380     |                     | 370    |                      |        | 134.11  | 0.98              | 0.722   |
|              |                | 1        |       |                |                |                |       |      |         |                     |        |                      |        |         |                   |         |
|              |                |          |       |                |                |                |       |      |         |                     | -      |                      |        |         |                   |         |
|              |                |          |       |                |                | -              |       |      |         |                     |        |                      |        |         |                   |         |
|              |                |          |       |                |                | -<br>-<br>-    |       |      |         |                     |        |                      |        |         |                   |         |
|              | -              |          | Sect  | Sectional area |                | of reinforcing | bar   |      |         | = du                | Coeff. | Coeff. from Nomogram | nogram | Stre    | Stress (kg/cm2)   | n2)     |
| f=M/N+U      | - ·            | p/i      |       | As             |                |                | As'   |      | As'/As  | n.As/bd             | 0      | s                    | Ζ.     | SIGc=   | SIGs=             | Tau≃    |
|              |                |          |       | (cm2)          |                |                | (cm2) |      |         |                     |        |                      |        | CM7bd^2 | 2~bd/.MSn         | ZQ/bd   |
|              |                |          | D19   | D19@200=14.33  | 1.33           |                |       |      |         | 0.006               | 20     | 173                  | 1.03   | 0.7     | 94                | 1.0     |
|              |                | ÷        | D19   | D19@200=14.33  | 4.33           |                |       |      |         | 0.006               | 20     | 173                  | 1.03   | 3.4     | 447               | 0.2     |
|              |                |          | D19   | D19@200=14.33  | 4.33           |                |       |      |         | 0.006               | 20     | 173                  | 1.03   | 19.6    | 2542              | 0.7     |
|              |                |          |       |                |                |                | -     |      |         |                     |        |                      |        |         |                   |         |
|              |                |          |       |                |                |                |       |      |         |                     |        |                      |        |         |                   |         |
|              |                |          |       |                |                |                |       |      |         |                     |        |                      |        |         |                   |         |
|              |                |          |       |                |                |                |       |      |         |                     |        |                      |        |         |                   |         |

Allowable stress : SIGca=60 & 90(\*) kg/cm2, SIGsa = 1,800 & 2,700(\*) kg/cm2, TAUa = 8 &12(\*) kg/cm2 • : Allowable stresses marked with (\*) are applied for the sesmic and flood conditions. n=Es/Ec=15,

| Load  |              |       | Inte        | Internal force | ce    |     |      | Section | Sectional dimension | nsion  |      |      |                      |                         |          |
|-------|--------------|-------|-------------|----------------|-------|-----|------|---------|---------------------|--------|------|------|----------------------|-------------------------|----------|
| Cond- | Cond- Member | Spot  | Spot Direc- | Ŵ              | σ     | z   | q    | ۹.      |                     | σ      | d,   | p/,p | M'=M+Nu M'/bd^2 Q/bd | M'/bd^2                 | Dd/D     |
| tion  |              |       | tion        | (t.m)          | E     | (I) | (cm) | (cm)    | (E)                 | (cm) ( | (cm) |      | (t.m)                | (t.m) (kg/cm2) (kg/cm2) | (kg/cm2) |
| Nor.  | Toe          | L O W |             | 9.81           | 19.42 |     | 100  | 100     |                     | 06     |      |      | 9.81                 | 9.81 1.211 2.158        | 2.158    |
| Seis. | Toe          | Moj   |             | 11.66 22.93    | 22.93 |     | 100  | 100     |                     | 06     |      |      | 11.66                | 11.66 1.44 2.548        | 2.548    |
| Flood | Toe          | Upper |             | 0.76           | 1.6   |     | 100  | 100     |                     | 06     |      |      | 0.76                 | 0.094 0.178             | 0.178    |
|       |              |       |             |                |       |     |      | <u></u> |                     |        | . '  | . –  |                      |                         |          |
|       |              |       |             |                |       |     |      |         |                     |        |      |      |                      |                         |          |
|       | -            |       |             |                |       |     |      |         |                     |        |      |      |                      |                         |          |
|       |              |       |             |                |       |     |      |         |                     |        |      |      |                      |                         |          |

|         |     | Sectional area of reinforci | orcing bar                            |                  | = du    | Coeff. 1   | np = Coeff. from Nomogram | nogram | Stre              | Stress (kg/cm2)                 | 12)           |
|---------|-----|-----------------------------|---------------------------------------|------------------|---------|------------|---------------------------|--------|-------------------|---------------------------------|---------------|
| f=M/N+u | f/d | As<br>(cm2)                 | As'<br>(cm2)                          | As'/As n.As/bd C | n.As/bd | ပ          | S                         | Z      | SIGc=<br>cM'/bd^2 | SIGc= SIGs=<br>cM/bd^2 nsM/bd^2 | Tau=<br>zo/bd |
|         |     | D19@200=14.33               |                                       |                  | 0.024   | 0.024 10.9 | 44.6                      | 1.07   | 13.2              | 810                             | 2.3           |
|         |     | D19@200=14.33               |                                       |                  | 0.024   | 0.024 10.9 | 44.6                      | 1.07   | 15.7              | 963                             | 2.7           |
|         |     | D19@200=14.33               |                                       |                  | 0.024   | 10.9       | 44.6                      | 1.07   | 44.6 1.07 1.0     | 63                              | 0.2           |
|         |     |                             | · · · · · · · · · · · · · · · · · · · |                  |         |            |                           |        |                   |                                 |               |
|         |     |                             |                                       |                  |         |            |                           |        |                   |                                 |               |
|         |     |                             |                                       |                  |         |            |                           |        |                   |                                 |               |
|         |     |                             |                                       |                  |         |            |                           |        |                   |                                 |               |

Allowable stress : SIGca=60 & 90(\*) kg/cm2, SIGsa = 1,800 & 2,700(\*) kg/cm2, TAUa = 8 &12(\*) kg/cm2 • : Allowable stresses marked with (\*) are applied for the sesmic and flood conditions.

n=Es/Ec=15,

|                   |              |              |                      |                      | U             | <u>nit : t•m</u> |
|-------------------|--------------|--------------|----------------------|----------------------|---------------|------------------|
| Nodal<br>Point    | D.L<br>(B.C) | D.L<br>(A.C) | L.L<br>Max.<br>(A.C) | L.L<br>Min.<br>(A.C) | Max.<br>(A.C) | Min.<br>(A.C)    |
| No. 1 Main Girder | r (G-1):     |              |                      |                      |               |                  |
| 1                 | - 0.0        | - 0.0        | 0.0                  | - 0.0                | 0.0           | - 0.0            |
| 4                 | 100.1        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
|                   | 100.1        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
| 7                 | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
|                   | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
| 10                | 182.2        | 27.8         | 137.3                | - 11.4               | 165.1         | 12.9             |
| · · · ·           | 182.2        | 27.8         | 137.3                | - 11.4               | 165.1         | 12.9             |
| 13                | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
|                   | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
| 16                | 100.1        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
|                   | 100.1        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
| 19                | - 0.0        | - 0.0        | 0.0                  | - 0.0                | 0.0           | - 0.0            |
| No. 2 Main Girder | $(G_{-2})$   |              | н.<br>1              |                      | · · · ·       | · · ·            |
| 2                 | 0.0          | 0.0          | 0.0                  | - 0.0                | 0.0           | 0.0              |
| 5                 | 98.0         | 10.5         | 80.1                 | - 0.0                | 90.6          | 10.4             |
| ~                 | 98.0         | 10.5         | 80.1                 | - 0.0                | 90.6          | 10.4             |
| 8                 | 161.2        | 26.1         | 122.7                | - 0.0                | 148.8         | 26.1             |
|                   | 161.2        | 26.1         | 122.7                | - 0.0                | 148.8         | 26.1             |
| 11                | 184.6        | 46.5         | 128.2                | - 0.0                | 174.7         | 46.5             |
|                   | 184.6        | 46.5         | 128.2                | - 0.0                | 174.7         | 46.5             |
| 14                | 161.2        | 26.1         | 122.7                | - 0.0                | 148.8         | 26.1             |
|                   | 161.2        | 26.1         | 122.7                | - 0.0                | 148.8         | 26.1             |
| 17                | 98.0         | 10.5         | 80.1                 | - 0.0                | 90.6          | 10.4             |
|                   | 98.0         | 10.5         | 80.1                 | - 0.0                | 90.6          | 10.4             |
| 20                | 0.0          | 0.0          | 0.0                  | - 0.0                | 0.0           | - 0.0            |
| No. 3 Main Girder | (6-3):       | · · ·        |                      |                      |               |                  |
| <u>3</u>          | ~ 0.0        | - 0.0        | 0.0                  | - 0.0                | 0.0           | - 0.0            |
| 6                 | 100.1        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
|                   | 100.1        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
| 9                 | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
|                   | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
| 12                | 182.2        | 27.8         | 137.3                | - 11.4               | 165.1         | 12.9             |
| 12                | 182.2        | 27.8         | 137.3                | - 11.4               | 165.1         | 12.9             |
| 15                | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
| 1.7               | 162.5        | 32.1         | 114.6                | - 7.6                | 146.7         | 22.3             |
| 18                | 102.5        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
| 10                | 100.1        | 22.5         | 66.8                 | - 3.7                | 89.3          | 17.7             |
| 21                | - 0.0        | - 0.0        | 0.0                  | - 0.0                | 0.0           | - 0.0            |
| 21                | - 0.0        | - 0.0        | 0.0                  | - 0.0                | 0.0           | ~ 0.0            |

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# SUMMARY OF BENDING MOMENT IN COMPOSITE GIRDER (Main Girder)

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Note : B.C : Before compounding

A.C : After compounding D.L : Moment due to dead load L.L : Moment due to live load

|                   |                |                |                      |                      | U             | <u>nit : ton</u> |
|-------------------|----------------|----------------|----------------------|----------------------|---------------|------------------|
| Nodal<br>Point    | D.L<br>(B.C)   | DL<br>(A.C)    | L.L<br>Max.<br>(A.C) | L.L<br>Min,<br>(A.C) | Max.<br>(A.C) | Min.<br>(A.C)    |
| No. 1 Main Girder | <u>(G-1)</u> : |                |                      |                      |               |                  |
| - 1               | 25.5           | 6.2            | 16.3                 | - 0.8                | 22.5          | 5.1              |
| 4                 | 17.1           | 3.4            | 13.2                 | - 2.0                | 16.6          | 0.7              |
|                   | 17.1           | 3.4            | 13.2                 | - 2.0                | 16.6          | 0.8              |
| 7                 | 8.4            | 0.5            | 10.2                 | - 4.1                | 10.8          | - 4.1            |
|                   | 8.4            | 0.5            | 10.2                 | - 4.1                | 10.8          | - 4.1            |
| 10                | - 0.4          | - 2.3          | 7.5                  | - 6.5                | 7.5           | - 8.8            |
|                   | 0.4            | 2.3            | 6.5                  | - 7.5                | 8.8           | - 7.5            |
| 13                | - 8.4          | - 0.5          | 4.1                  | - 10.2               | 4.1           | - 10.8           |
|                   | - 8.4          | - 0.5          | 4 1                  | - 10.2               | 4.1           | - 10.8           |
| 16                | - 17.1         | - 3.4          | 2.0                  | - 13.2               | - 0.8         | - 16.6           |
| -                 | - 17.1         | - 3.4          | 2.0                  | - 13.2               | - 0.7         | -16.6            |
| 19                | - 25.5         | - 6.2          | 0.8                  | - 16.3               | - 5.1         | - 22.5           |
| No. 2 Main Girder | · (G-2)·       |                |                      |                      |               |                  |
| 2                 | 24.7           | 1.8            | 21.5                 | - 0.3                | 23.2          | 1.3              |
| 5                 | 17.0           | 2.7            | 15.7                 | - 3.3                | 18.4          | - 1.6            |
| <i>.</i> ,        | 17.0           | 2.7            | 15.7                 | - 3.3                | 18.4          | - 1.6            |
| 8                 | 8.8            | 3.7            | 11.0                 | - 7.4                | 14.7          | - 5.9            |
| 0                 | 8.8            | 3.7            | 11.0                 | - 7.4                | 14.7          | - 5.9            |
| 11                | 0.7            | 4.7            | 7.4                  | - 11.8               | 12.1          | -10.7            |
|                   | - 0.7          | - 4.7          | 11.8                 | - 7.4                | 10.7          | - 12.1           |
| 14                | - 8.8          | - 3.7          | 7.4                  | - 11.0               | 5.9           | - 14.7           |
| 14                | - 8.8          | - 3.7          | 7.4                  | - 11.0               | 5.9           | - 14.7           |
| 1-7               |                | - 3.7<br>- 2.7 | .3.3                 | - 15.7               | 1.6           | - 18.4           |
| 17                | - 17.0         |                | 3.3                  | - 15.7               | 1.6           | - 18.4           |
|                   | - 17.0         | - 2.7          | 0.3                  | - 15.7<br>- 21.5     | - 1.3         | - 23.2           |
| 20                | - 24.7         | - 1.8          | 0.5                  | - 21.5               | - 1.5         |                  |
| No. 3 Main Girder |                |                |                      |                      | 00.5          | εī               |
| - 3               | 25.5           | 6.2            | 16.3                 | - 0.8                | 22.5          | 5.1              |
| 6                 | 17.1           | 3.4            | 13.2                 | - 2.0                | 16.6          | . 0.7            |
|                   | 17.1           | 3.4            | 13.2                 | - 2.0                | 16.6          | 0.8              |
| 9                 | 8.4            | 0.5            | 10.2                 | - 4.1                | 10.8          | - 4.1            |
|                   | 8.4            | 0.5            | 10.2                 | - 4.1                | 10.8          | - 4,1            |
| 12                | - 0.4          | - 2.3          | 7.5                  | - 6.5                | 7.5           | - 8.8            |
|                   | 0.4            | 2.3            | 6.5                  | - 7.5                | 8.8           | - 7.5            |
| 15                | - 8.4          | - 0.5          | 4.1                  | - 10.2               | 4.1           | - 10.8           |
|                   | - 8.4          | - 0.5          | 4 1                  | - 10.2               | 4.1           | - 10.8           |
| 18                | - 17.1         | - 3.4          | 2.0                  | - 13.2               | - 0.8         | - 16.6           |
|                   | - 17.1         | - 3.4          | 2.0                  | - 13.2               | - 0.7         | - 16.6           |
| 21                | - 25.5         | - 6.2          | 0.8                  | - 16.3               | - 5.1         | - 22.5           |

# Table 4.1.22 SUMMARY OF SHARE FORCE IN COMPOSITE GIRDER (Main Girder)

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Note : B.C : Before compounding A.C : After compounding D.L : Share due to dead load L.L : Share due to live load

|                          |              |              |                   | <u>Unit : ton</u>       |
|--------------------------|--------------|--------------|-------------------|-------------------------|
| Nodal<br>Point           | D.L<br>(B.C) | D.L<br>(A.C) | L.L<br>Max. (A.C) | Total Reaction<br>Force |
| No. 1 Main Girder (G-1): |              |              |                   |                         |
| 1                        | 25.5         | 6.2          | 16.3              | 48.0                    |
| 19                       | 25.5         | 6.2          | 16.3              | 48.0                    |
| No. 2 Main Girder (G-2): |              | . :<br>. :   |                   |                         |
| 2                        | 24.7         | 1.8          | 21.5              | 47.9                    |
| 20                       | 24.7         | 1.8          | 21.5              | 47.9                    |
| No. 3 Main Girder (G-3): |              |              |                   |                         |
| 3                        | 25.5         | 6.2          | 16.3              | 48.0                    |
| 21                       | 25.5         | 6.2          | 16.3              | 48.0                    |

# Table 4.1.23 SUMMARY OF REACTION FORCE AT\_\_\_\_SUPPORTS

B.C : A.C : D.L : L.L : Note :

Before compounding After compounding Reaction due to dead load

Reaction due to live load

# Table 4.1.24 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 1 MAIN GIRDER, NO. 1 SECTION)

| • | Bending moment before compoundingMS =              | 101.88       | t•m |
|---|--|--------------|-----|
| - | Bending moment after compoundingMV =               | <u>90.90</u> | t•m |
| - | Bending moment by dead load after compoundingMVD = | 22.84        | i∙m |
| - | Base slab thicknessTS =                            | 18.0         | cm  |
| - | Haunch   | _6.0         | стп |
|   | Effective base slab widthBS =                      | <u>228.1</u> | cm  |
| - | Distance between fixed points of flangeP =         | <u>490.0</u> | cm  |
|   |  |              |     |

- Section and sectional area of steel girder:

|                                  |   | Section (mm)     | Sectional Area (cm <sup>2</sup> ) |
|----------------------------------|---|------------------|-----------------------------------|
| • Upper flange<br>• Web          | : | <u>230 x 11</u>  | 25.3 (SM50Y)                      |
| • Web                            | : | <u>1,550 x 9</u> | <u>139,5</u> (SM50Y)              |
| <ul> <li>Lower flange</li> </ul> | : | <u>_280 x 11</u> | <u>30.8</u> (SM50Y)               |
|                                  |   |                  |                                   |
| TOTAL                            |   |                  | <u>195.6</u>                      |

- Sectional area and moment of inertia of area:

|  | Sectional Area | Moment of Inertia          |
|--|----------------|----------------------------|
|  | <u>(cm²)</u>   | of Area (cm <sup>4</sup> ) |
| Concrete section                         | : AC = 4.105   | IC = 110,832               |
| <ul> <li>Steel girder section</li> </ul> | : AS = 195.6   | IS = <u>620.099</u>        |
| <ul> <li>Composite section</li> </ul>    | : AV = 782     | IV = 1.951.186             |

- Geometrical moment of area of concrete (AC x DC)......QC = <u>97,226</u> cm<sup>3</sup>

- Distance and section modulus (See Fig.4.4.7):

| Distar | <u>1ce (cm)</u> | Section Mc   | <u>odulus (cm²)</u> |
|--------|-----------------|--------------|---------------------|
| D⇒     | 94.7            | WSU =        | 7,675               |
| DS =   | 71.0            | $WSL \simeq$ | 8,116               |
| DC =   | 23.7            | WVU =        | 199.399             |
| YSU =  | 80.8            | WVL=         | 13,236              |
| YSL=   | 76.4            |              |                     |
| YVU =  | <u>9.8</u>      |              |                     |
| YVL=   | 147.4           |              |                     |
| YVC =  | 32.7            |              |                     |

- Axial force

| Due to drying schrinkage     Due to creep |          | NSH =<br>NCR = | $\frac{17.1}{2.5}$ | ton<br>ton |
|---|----------|----------------|--------------------|------------|
| Due to temperature change                 |          | NTM =          | 12.0               | ton        |
| Stress (kg/cm <sup>2</sup> ):             | <b>6</b> |                |                    | 7          |

| · · · ·   | Concrete<br>Base Slab          | Upper<br>Flange                  | Lower<br>Flange                      |
|---|--------------------------------|----------------------------------|--------------------------------------|
| (1) Stress before compounding                         | -                              | - 1.327                          | 1,255                                |
| (2) Stress after compounding                          | - 21.8                         | - 46                             | 687                                  |
| (3) Stress due to drying schrinkage                   | 3.1                            | - 297                            | 110                                  |
| (4) Stress due to creep                               | 1.9                            | - 42                             | 16                                   |
| (5) Stress due to temperature difference              | - 0.6                          | - 207                            | 75                                   |
| (6) = (1)<br>Allowable stress                         |                                | - 1.327                          | <u>    1,255</u><br><u>    2,625</u> |
| (7) = (1) + (2)<br>Allowable stress                   | - 21.8                         | <u>- 1,373</u><br><u>- 2,100</u> | 1.942                                |
| (8) = (1) + (2) + (3) + (4)<br>Allowable stress       | - 16.8<br>- 77.1               | <u>- 1,712</u><br><u>- 2,415</u> | 2.068                                |
| (9) = (1) + (2) + (3) + (4) + (5)<br>Allowable stress | - <u>17.5</u><br>- <u>88.7</u> | <u>- 1,918</u><br><u>- 2,730</u> | 2.143                                |

#### Table 4.1.25 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 1. MAIN GIRDER, NO. 2. SECTION)

| - | Bending moment before compoundingMS =              | 182.18       | t•m |
|---|--|--------------|-----|
| • | Bending moment after compoundingMV =               | 165.06       | t•m |
| - | Bending moment by dead load after compoundingMVD = | 27.76        | t•m |
| - | Base slab thicknessTS =                            | 18.0         | cm  |
| • | HaunchHH =   | 6.0          | cm  |
| - | Effective base slab widthBS =                      | 228.1        | cm  |
| - | Distance between fixed points of flangeP =         | <u>490.0</u> | cm  |
| • | Section and sectional area of steel girder:        |              |     |

Section and sectional area of steel glucer:

| 1                                | 11 | Section (mm)     | <u>Sectional Area (cm<sup>2</sup>)</u> |
|----------------------------------|----|------------------|--|
| • Upper flange<br>• Web          | :  | <u>280 x 14</u>  | <u>39.2</u> (SM50Y)                    |
| • Web                            | :  | <u>1,550 x 9</u> | <u>139.5</u> (SM50Y)                   |
| <ul> <li>Lower flange</li> </ul> | :  | <u>440</u> x 19  | <u>83.6</u> (SM50Y)                    |

262.3

TOTAL

- Sectional area and moment of inertia of area:

|                       | Sectional Area     | Moment of Inertia          |
|-----------------------|--------------------|----------------------------|
|                       | (cm <sup>2</sup> ) | of Area (cm <sup>±</sup> ) |
| Concrete section :    | AC = 4.105         | IC = 110.832               |
| Steel girder section  |                    | IS = 987.001               |
| • Composite section : | $AV ={849}$        | IV = 3.032.152             |

- Geometrical moment of area of concrete (AC x DC)......QC = 134,244 cm<sup>3</sup>

- Distance and section modulus (See Fig. 4.4.7):

| Distan | <u>ce (cm)</u> | Section Mo | dulus (cm <sup>2</sup> ) |
|--------|----------------|------------|--------------------------|
| D =    | 105.8          | WSU =      | 10,703                   |
| DS =   | 73.1           | WSL =      | 14.936                   |
| DC ==  | 32.7           | WVU =      | <u>158,724</u>           |
| YSU =  | 92.2           | WVL =      | 21,783                   |
| YSL =  | 66.1           |            |                          |
| ¥VU ≕  | 19.1           |            |                          |
| YYL =  | 139.2          |            |                          |
| YVC =  | 41.7           |            |                          |

- Axial force

| • Due to drying schrinkageNSH = | 20.8 | ton |
|---------------------------------|------|-----|
| • Due to creepNCR =             | 3.3  | ion |
| Due to temperature changeNTM =  | 15.1 | ton |

- Stress (kg/cm2): Upper Lower Concrete Flange Flange Base Slab - 1,702 1,220 (1) Stress before compounding • - 32.4 - 104 758 (2) Stress after compounding (3) Stress due to drying schrinkage 4.1 - 284 67 (4) Stress due to creep 1.7 - 44 10 · 205 48 (5) Stress due to temperature difference - 1.6 . 1.702 1.220 (6) = (1)Allowable stress . 1,765 2,625 - 32.4 (7) = (1) + (2)- 1,806 1,977 - 77.1 2.100 Allowable stress 2,100 - 26.6 2,055 (8) = (1) + (2) + (3) + (4)- 2,134 - 77.1 Allowable stress - 2,415 2,100 - 2.338 2,103 (9) = (1) + (2) + (3) + (4) + (5)- 28.2 - 88.7 2,730 2,415 Allowable stress

#### Table 4.1.26 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 1 MAIN GIRDER, NO. 3 SECTION)

|   | ·   |             |              |     |
|---|---|-------------|--------------|-----|
| • | Bending moment before compounding             | 4S =        | 101.89       | i•m |
| • | Bending moment after compounding              | fV =        | <u>90.91</u> | ŀm  |
| • | Bending moment by dead load after compounding | ſVD≃        | 22.85        | ŀ'n |
| • | Base slab thickness                           | <u>`S =</u> | 18.0         | cm  |
| * | Haunch  | IH =        | 6.0          | cm  |
| - | Effective base slab widthE                    | 3S ==       | <u>228.1</u> | cm  |
| • | Distance between fixed points of flange       | , ≈         | <u>490.1</u> | cm  |
| - | Section and sectional area of steel girder:   | · .         |              |     |
|   |   |             |              |     |

| • Upper flange<br>• Web<br>• Lower flange | : | $\frac{\text{Section (mm)}}{230 \times 11}$ $\frac{230 \times 11}{1.550 \times -9}$ $\frac{280 \times 11}{11}$ | <u>Sectional Area (cm²)</u><br><u>25.3</u> (SM50Y)<br><u>139.5</u> (SM50Y)<br><u>30.8</u> (SM50Y) |
|---|---|--|---|
| TOTAL.                                    |   |  | <u>195.6</u>  |

- Sectional area and moment of inertia of area:

|  | Sectional Area | Moment of Inertia          |
|--|----------------|----------------------------|
|  | <u>(cm²)</u>   | of Area (cm <sup>4</sup> ) |
| <ul> <li>Concrete section</li> </ul>     | AC = 4,105     | IC = 110,832               |
| <ul> <li>Steel girder section</li> </ul> | AS = 195.6     | IS = 620.099               |
| <ul> <li>Composite section</li> </ul>    | $: AV ={782}$  | IV = 1.951,186             |

- Geometrical moment of area of concrete (AC x DC)......QC = <u>97,226</u> cm<sup>3</sup>

- Distance and section modulus (See Fig. 4.4.7):

| Distance (cm) |       | Section Modulus (cm <sup>2</sup> ) |         |  |
|---------------|-------|------------------------------------|---------|--|
| D =           | 94.7  | WSU =                              | 7;675   |  |
| DS =          | 71.0  | WSL =                              | 8,116   |  |
| DC =          | 23.7  | WVU ==                             | 199.399 |  |
| YSU =         | 80.8  | WVL=                               | 13,236  |  |
| YSL =         | 76.4  |                                    |         |  |
| YYÜ =         | 9.8   |                                    |         |  |
| YVL=          | 147.4 |                                    |         |  |
| YVC =         | 32.7  |                                    |         |  |

- Axial force

| • Due to drying schrinkageNSH =  | 17.1        | ton |
|----------------------------------|-------------|-----|
| • Due to creepNCR =              | 2.5         | ton |
| • Due to temperature changeNTM = | <u>12.0</u> | ton |

- Stress (kg/cm<sup>2</sup>):

| Stress (kg/cm <sup>2</sup> ):                         | Concrete<br>Base Slab   | Upper<br>Flange                  | Lower<br>Flange       |
|---|-------------------------|----------------------------------|-----------------------|
| (1) Stress before compounding                         | -                       | - 1,328                          | 1,255                 |
| (2) Stress after compounding                          | - 21.8                  | - 46                             | 687                   |
| (3) Stress due to drying schrinkage                   | 3.1                     | - 297                            | 110                   |
| (4) Stress due to creep                               | 1.9                     | - 42                             | 16                    |
| (5) Stress due to temperature difference              | 0.6                     | - 207                            | 75                    |
| (6) = (1)<br>Allowable stress                         |                         | <u>- 1,328</u><br><u>- 1,412</u> | 1.255                 |
| (7) = (1) + (2)<br>Allowable stress                   | - 21.8                  | - 1,373                          | <u>1,942</u><br>2,100 |
| (8) = (1) + (2) + (3) + (4)<br>Allowable stress       | - 16.8                  | - 1,712<br>- 2,415               | 2,068                 |
| (9) = (1) + (2) + (3) + (4) + (5)<br>Allowable stress | <u>- 17.5</u><br>- 88.7 | - 1.918<br>- 2.730               | 2,144                 |

### Table 4.1.27 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 2. MAIN GIRDER, NO. 1. SECTION)

|   |   | <u>99,73</u> | t•m |
|---|---|--------------|-----|
| ٠ | Bending moment after compoundingMV =                  | 92.14        | t•m |
| - | Bending moment by dead load after compounding $MVD =$ | 10.68        | ۱۰m |
| - | Base slab thicknessTS ==                              | 18.0         | ċm  |
| - | HaunchHH =  | 2.2          | cm  |
| - | Effective base slab widthBS =                         | <u>263.9</u> | cm  |
| • | Distance between fixed points of flangeP =            | <u>490.0</u> | cm  |
| - | Section and sectional area of steel girder:           |              |     |

| • Upper flange<br>• Web<br>• Lower flange | : | <u>Section (mm)</u><br><u>230</u> x 10<br><u>1,550</u> x 9<br><u>280</u> x 11 | <u>Sectional Area (cm<sup>2</sup>)</u><br><u>23.0</u> (SM50Y)<br><u>139.5</u> (SM50Y)<br><u>30.8</u> (SM50Y) |
|---|---|---|--|
| TOTAL                                     |   |   | <u>193.3</u>   |

- Sectional area and moment of inertia of area:

|  | Sectional Area          | Moment of Inertia               |
|--|-------------------------|---------------------------------|
|  | <u>(cm<sup>2</sup>)</u> | <u>of Area (cm<sup>2</sup>)</u> |
| <ul> <li>Concrete section</li> </ul>     | : AC = 4.750            | IC = 128,255                    |
| <ul> <li>Steel girder section</li> </ul> | AS = 193.3              | IS = 604,926                    |
| <ul> <li>Composite section</li> </ul>    | : AV = 872              | IV = 2.114.354                  |

- Geometrical moment of area of concrete (AC x DC)......QC = 104,844 cm<sup>3</sup> - Distance and section modulus (See Fig. 4.4.7):

| 20101100 | - |          |    | (0000.0 |  |
|----------|---|----------|----|---------|--|
|          |   |          |    |         |  |
|          |   | Distance | 1. | · \     |  |

| Distance (cm) |        | Section Modulus (cm <sup>2</sup> ) |         |  |
|---------------|--------|------------------------------------|---------|--|
| D ==          | 99.6   | WSU =                              | 7,408   |  |
| DS =          | 77.5   | WSL =                              | 8,018   |  |
| DC.=          | _22.1_ | WVU≈                               | 506.868 |  |
| YSU =         | 81.7   | WVL=                               | 13,826  |  |
| YSL =         | 75.4   |                                    |         |  |
| YVU =         | 4.2    |                                    |         |  |
| YVL =         | 152.9  |                                    |         |  |
| YVC =         | 31.1   |                                    |         |  |

Axial force

\_

| Due to drying schrinkage      | 1.0 | ton<br>ton<br>ton |
|-------------------------------|-----|-------------------|
| Stress (kg/cm <sup>2</sup> ): |     | 1                 |

|   | Concrete<br>Base Slab          | Upper<br>Flange                  | Lower<br>Flange       |
|---|--------------------------------|----------------------------------|-----------------------|
| (1) Stress before compounding                         | -                              | - 1,346                          | 1,244                 |
| (2) Stress after compounding                          | - 19.3                         | - 18                             | 666                   |
| (3) Stress due to drying schrinkage                   | 2.3                            | - 301                            | 116                   |
| (4) Stress due to creep                               | 0.7                            | - 17                             | 6                     |
| (5) Stress due to temperature difference              | - 0.1                          | - 204                            | 77                    |
| (6) = (1)<br>Allowable stress                         |                                | - 1,346                          | <u>1.244</u><br>2.625 |
| (7) = (1) + (2)<br>Allowable stress                   | - 19.3                         | - 1.364<br>- 2,100               | <u> </u>              |
| (8) = (1) + (2) + (3) + (4)<br>Allowable stress       | <u> </u>                       | - 1,682<br>- 2,415               | 2.033                 |
| (9) = (1) + (2) + (3) + (4) + (5)<br>Allowable stress | <u>- 16.4</u><br><u>- 88.7</u> | <u>- 1,886</u><br><u>- 2,730</u> | 2,109                 |

## Table 4.1.28 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 2 MAIN GIRDER, NO. 2 SECTION)

| - Bending moment before compoundingMS =              | 184,64       | t•m  |
|--|--------------|------|
| - Bending moment after compoundingMV =               | 174.66       | t•m  |
| - Bending moment by dead load after compoundingMVD = | 46.45        | ∶t•m |
| Base slab thicknessTS =                              | 18.0         | cm   |
| - HaunchHH =   | 9.9          | ¢m   |
| - Effective base slab widthBS =                      | <u>263.9</u> | ċm   |
| - Distance between fixed points of flangeP =         | <u>490.0</u> | cm   |
| - Section and sectional area of steel girder:        |              |      |

|                                  |   | Section | <u>(mm)</u> | <u>Sectional</u> | Area (cm <sup>2</sup> ) |
|----------------------------------|---|---------|-------------|------------------|-------------------------|
| <ul> <li>Upper flange</li> </ul> |   | 280     | x <u>14</u> | 39.2             | (03,001)                |
| • Web                            | : | 1,550   | <u>x 9</u>  | <u>139.5</u>     | (SM50Y)                 |
| <ul> <li>Lower flange</li> </ul> | : | 450     | x <u>19</u> | 85.5             | (SM50Y)                 |
|                                  |   |         |             |                  |                         |

<u>264.2</u>

TOTAL - Sectional area and moment of inertia of area:

| a ga a                                | Sectional Area             | Moment of Inertia                                  |
|---------------------------------------|----------------------------|--|
| Concrete section                      | AC = 4.750                 | $IC = \frac{\text{of Area}(\text{cm}^4)}{128,255}$ |
| Steel girder section                  | AC = 4.750<br>: AS = 264.2 | IC = 128,255<br>IS = 995,003                       |
| <ul> <li>Composite section</li> </ul> | : AV = 943                 | IV = 3.322.056                                     |

- Geometrical moment of area of concrete (AC x DC).....QC = 146,672 cm<sup>3</sup> - Distance and section modulus (See Fig. 4.4.7):

| Distan | ice (¢m) | Section Mc | dulus (cm <sup>3</sup> ) |
|--------|----------|------------|--------------------------|
| D ==   | 110.2    | WSU =      | 10,735                   |
| DS =   | 79.3     | WSL =      | 15,164                   |
| DC =   | 30.9     | WVU =      | <u>248,339</u>           |
| YSU =  | 92.7     | WVL=       | 22.923                   |
| YSL =  | 65.6     |            |                          |
| YVU =  | 13.4     |            |                          |
| YVL≕   | 144.9    |            |                          |
| YVC =  | 39.9     |            |                          |

- Axial force

| <ul> <li>Due to drying schrinkageNSH =</li> </ul> | 20.7 | ion |
|---|------|-----|
| • Due to creepNCR =                               | 4.7  | ton |
| Due to temperature changeNTM =                    | 14,6 | ion |

- Stress (kg/cm<sup>2</sup>):

| Stress (kg/cm²):                                      | Concrete<br>Base Slab   | Upper<br>Flange           | Lower<br>Flange       |
|---|-------------------------|---------------------------|-----------------------|
| (1) Stress before compounding                         | <u> </u>                | - 1,720                   | 1,218                 |
| (2) Stress after compounding                          | - 30.0                  | - 70                      | 762                   |
| (3) Stress due to drying schrinkage                   | 3.4                     | - 289                     |                       |
| (4) Stress due to creep                               | 2.4                     | - 64                      | 16                    |
| (5) Stress due to temperature difference              | - 1.0                   | 203                       | 49                    |
| (6) = (1)<br>Allowable stress                         |                         | <u>- 1,720</u><br>- 1,765 | 1.218                 |
| (7) = (1) + (2)<br>Allowable stress                   | - 30.0                  | - 1,790                   | <u>1.980</u><br>2,100 |
| (8) = (1) + (2) + (3) + (4)<br>Allowable stress       | - 24.1                  | - 2,143                   | 2,066                 |
| (9) = (1) + (2) + (3) + (4) + (5)<br>Allowable stress | <u>- 25.2</u><br>- 88.7 | - 2.346                   | 2.115                 |

## Table 4.1.29 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 2 MAIN GIRDER, NO. 3 SECTION)

| - Bending mom     | ent before compounding             | MS =    | .99.75       | t•m |
|-------------------|------------------------------------|---------|--------------|-----|
| - Bending mom     | ent after compounding              | MV =    | 92.16        | t•m |
| - Bending mom     | ent by dead load after compounding | MVD =   | 10.68        | t+m |
| - Base slab thick | kness                              | TS ==   | 18.0         | cm  |
| - Haunch          |                                    | HH =    | 99           | cm  |
| - Effective base  | slab width                         | BS =    | 263.9        | cm  |
| - Distance betw   | een fixed points of flange         | P =     | <u>490.0</u> | cm  |
| - Section and se  | ctional area of steel girder:      |         |              |     |
|                   | Section ()                         | Continu | 1 1          |     |

| • Upper flange<br>• Web<br>• Lower flange | <br>$\begin{array}{r} \underline{\text{Section (mm)}}\\ \underline{230} \times \underline{10}\\ \underline{1.550} \times \underline{9}\\ \underline{280} \times \underline{11} \end{array}$ | <u>Sectional Area (cm<sup>2</sup>)</u><br><u>23.0</u> (SM50Y)<br><u>139.5</u> (SM50Y)<br><u>30.8</u> (SM50Y) |
|---|---|--|
| TOTAL                                     |   | <u>193.3</u>   |

- Sectional area and moment of inertia of area:

| . 1                                      | Sectional Area          | Moment of Inertia          |
|--|-------------------------|----------------------------|
|  | <u>(cm<sup>2</sup>)</u> | of Area (cm <sup>4</sup> ) |
| <ul> <li>Concrete section</li> </ul>     | AC = 4.750              | IC = 128,255               |
| <ul> <li>Steel girder section</li> </ul> | AS = 193.3              | IS = <u>604.926</u>        |
| <ul> <li>Composite section</li> </ul>    | : AV = 872              | IV = 2.114.354             |

- Geometrical moment of area of concrete (AC x DC)......QC = <u>104,844</u> cm<sup>3</sup>

- Distance and section modulus (See Fig. 4.4.7):

| Distance (cm) |       | Section Mo | <u>dulus (cm²)</u> |
|---------------|-------|------------|--------------------|
| D =           | 99.6  | WSU =      | 7,408              |
| DS =          | 77.5  | WSL =      | 8,018              |
| DC =          | 22.1  | WVU =      | 506.868            |
| YSU =         | 81.7  | WVL =      | 13,826             |
| YSL =         | 75.4  |            |                    |
| YYU =         | 4.2   |            |                    |
| YVL =         | 152.9 |            |                    |
| YVC =         | 31.1  |            |                    |

- Axial force

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| Stress (kg/cm²):                         | Concrete  | Upper   | Lower  |
|--|-----------|---------|--------|
|  | Base Slab | Flange  | Flange |
| (1) Stress before compounding            | -         | - 1,346 | 1,244  |
| (2) Stress after compounding             | - 19.3    | - 18    | 667    |
| (3) Stress due to drying schrinkage      | 2.3       | - 301   | 116    |
| (4) Stress due to creep                  | 0.7       | - 17    | 6      |
| (5) Stress due to temperature difference | - 0.1     | - 204   |        |
| (6) = (1)                                |           | - 1,346 | 1.244  |
| Allowable stress                         | -         | - 1,379 | 2.625  |
| (7) = (1) + (2)                          | - 19.3    | - 1,365 | 1.911  |
| Allowable stress                         | - 77.1    | - 2.100 | 2.100  |
| (8) = (1) + (2) + (3) + (4)              | - 16.3    | - 1.682 | 2,033  |
| Allowable stress                         | - 77.1    | - 2.415 | 2,100  |
| (9) = (1) + (2) + (3) + (4) + (5)        | - 16.4    | - 1,886 | 2,110  |
| Allowable stress                         | - 88.7    | - 2,730 | 2,415  |

# Table 4.1.30 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 3 MAIN GIRDER, NO. 1 SECTION)

|   | •   |        |              |     |
|---|---|--------|--------------|-----|
| - | Bending moment before compounding             | .MS =  | 101.88       | t•m |
| • | Bending moment after compounding              | .MV =  | <u>90.90</u> | t•m |
| ÷ | Bending moment by dead load after compounding | .MVD = | 22.84        | t•m |
| • | Base slab thickness                           | .TS =  | 18.0         | cm  |
| - | Haunch  | .HH =  | _6.0         | cm  |
| - | Effective base slab width                     | .BS =  | 228.1        | стп |
| - | Distance between fixed points of flange       | .P =   | <u>490.0</u> | cm  |
| - | Section and sectional area of steel girder:   |        | . "          |     |
|   |   |        |              |     |

| • Upper flange<br>• Web<br>• Lower flange | : | $\begin{array}{r} \underline{\text{Section (mm)}} \\ \underline{230 \times 11} \\ \underline{1.550 \times 9} \\ \underline{280 \times 11} \end{array}$ | <u>Sectional Area (cm<sup>2</sup>)</u><br><u>25.3</u> (SM50Y)<br><u>139.5</u> (SM50Y)<br><u>30.8</u> (SM50Y) |
|---|---|--|--|
| TOTAL                                     |   |  | <u>195.6</u>   |

- Sectional area and moment of inertia of area:

|  | Sectional Area          | Moment of Inertia          |
|--|-------------------------|----------------------------|
|  | <u>(cm<sup>2</sup>)</u> | of Area (cm <sup>4</sup> ) |
| <ul> <li>Concrete section</li> </ul>     |                         | IC = 110,832               |
| <ul> <li>Steel girder section</li> </ul> | : AS = 195.6            | IS = <u>620.099</u>        |
| <ul> <li>Composite section</li> </ul>    | $: AV ={782}$           | IV = <u>1,951,186</u>      |

 Geometrical moment of area of concrete (AC x DC)......QC = <u>97,226</u> cm<sup>3</sup>

- Distance and section modulus (See Fig. 4.4.7):

| Distan | ce (cm) | Section Mc | dulus (cm <sup>3</sup> ) |
|--------|---------|------------|--------------------------|
| D =    | 94.7    | WSU =      | 7,675                    |
| DS =   |         | WSL =      | 8,116                    |
| DC =   | 23.7    | WVU =      | <u>199.399</u>           |
| YSU =  | 80.8    | WVL=       | 13,236                   |
| YSL =  | 76.4    |            |                          |
| YVU =  | 9.8     |            |                          |
| YVL=   | 147.4   |            |                          |
| YVC =  | 32.7    |            |                          |

- Axial force

| Due to drying schrinkage | k = 2.5 | ton<br>ton<br>ton |
|--------------------------|---------|-------------------|
|--------------------------|---------|-------------------|

mass (Valem2)

| Stress (kg/cm²):                                      | Concrete<br>Base Slab | Upper<br>Flange | Lower<br>Flange |
|---|-----------------------|-----------------|-----------------|
| (1) Stress before compounding                         | *                     | - 1,327         | 1,255           |
| (2) Stress after compounding                          | - 21.8                | - 46            | .687            |
| (3) Stress due to drying schrinkage                   | 3.1                   | - 297           | 110             |
| (4) Stress due to creep                               | 1.9                   | - 42            | 16              |
| (5) Stress due to temperature difference              | - 0.6                 | - 207           |                 |
| (6) = (1)<br>Allowable stress                         |                       | - 1.327         | 1,255           |
| (7) = (1) + (2)<br>Allowable stress                   | - 21.8                | <u> </u>        | 1,942           |
| (8) = (1) + (2) + (3) + (4)<br>Allowable stress       | - 16.8                | - 1.712         | 2,068           |
| (9) = (1) + (2) + (3) + (4) + (5)<br>Allowable stress | - 17.5<br>- 88.7      | <u> </u>        | 2,143 2.415     |

## Table 4.1.31 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 3 MAIN GIRDER, NO. 2 SECTION)

| - | Bending moment before compoundingMS =              | 182.18       | t•m |
|---|--|--------------|-----|
| - | Bending moment after compoundingMV =               | 165.06       | t•m |
| - | Bending moment by dead load after compoundingMVD = | 27.76        | t•m |
|   | Base slab thicknessTS =                            | 18.0         | cm  |
| - | HaunchHH =   | 6.0          | cm  |
| - | Effective base slab widthBS =                      | 228.1        | cm  |
| - | Distance between fixed points of flangeP =         | <u>490.0</u> | cm  |
|   | Section and sectional area of steel girder:        |              |     |

Section and sectional area of steel girder:

| 1                                |   | Section (mm)     | Sectional Area (cm <sup>2</sup> ) |
|----------------------------------|---|------------------|-----------------------------------|
| Upper flange     Web             | : | <u>280 x 14</u>  | <u>39,2</u> (\$M50Y)              |
|                                  | : | <u>1.550 x 9</u> | <u>139.5</u> (SM50Y)              |
| <ul> <li>Lower flange</li> </ul> | : | <u>440 x 19</u>  | <u>83.6</u> (SM50Y)               |
| TOTAL                            |   |                  | <u>262.3</u>                      |

- Sectional area and moment of inertia of area:

| 1  | Sectional Area     | Moment of Inertia          |
|--|--------------------|----------------------------|
| and the second second second second second second second second second second second second second second second | (cm <sup>2</sup> ) | of Area (cm <sup>4</sup> ) |
| Concrete section : AC  |                    | IC = 110,832               |
| <ul> <li>Steel girder section : AS</li> </ul>  | = <u>262.3</u>     | IS = <u>987.001</u>        |
| • Composite section : AV   | ' = 849            | IV = 3.032.152             |

- Geometrical moment of area of concrete (AC x DC)......QC = 134.244 cm<sup>3</sup>

- Distance and section modulus (See Fig. 4.4.7):

| Distance (cm) |              | Section Mo | <u>dulus (cm²)</u> |
|---------------|--------------|------------|--------------------|
| D =           | 105.8        | WSU =      | 10,703             |
| DS =          | 73.1         | WSL =      | 14,936             |
| DC =          | 32.7         | WVU =      | 158,724            |
| YSU =         | 92.2         | WYL =      | 21,783             |
| YSL =         | 66.1         | 1          |                    |
| YVU =         | 19.1         |            |                    |
| YVL =         | <u>139.2</u> |            | 1                  |
| YVC =         | 41.7         |            |                    |

| - Axial force   |                       |                                  |                           |
|---|-----------------------|----------------------------------|---------------------------|
| Due to drying schrinkage     Due to creep     Due to temperature change |                       | NCR = 3.3                        | ton<br>ton<br>ton         |
| - Stress (kg/cm²):  | Concrete<br>Base Slab | Upper<br>Flange                  | Lower<br>Flange           |
| (1) Stress before compounding   | • *                   | - 1,702                          | 1,220                     |
| (2) Stress after compounding  | - 32.4                | - 104                            | 758                       |
| (3) Stress due to drying schrinkage                                     | 4.1                   | - 284                            | 67                        |
| (4) Stress due to creep   | 1.7                   | - 44                             | 10                        |
| (5) Stress due to temperature difference                                | - 1.6                 | - 205                            | 48                        |
| (6) = (1)<br>Allowable stress   |                       | - 1,702<br>- 1,765               | <u>    1,220</u><br>2,625 |
| (7) = (1) + (2)<br>Allowable stress                                     | - 32.4                | - 1,806                          | 1.977                     |
| (8) = (1) + (2) + (3) + (4)<br>Allowable stress                         | 26.6                  | <u>- 2,134</u><br><u>- 2,415</u> | 2,055                     |
| (9) = (1) + (2) + (3) + (4) + (5)<br>Allowable stress                   | - 28.2                | - 2.338<br>- 2,730               | 2,103                     |

#### Table 4.1.32 STRESS ANALYSIS RESULT OF COMPOSITE GIRDER (NO. 3\_MAIN GIRDER, NO. 3\_SECTION)

| <ul> <li>Bending moment before compoundingMS =</li> </ul>      | 101.89       | [*m |  |
|--|--------------|-----|--|
| - Bending moment after compoundingMV =                         | 90.91        | t•m |  |
| - Bending moment by dead load after compoundingMVD =           | 22.85        | ŀņ. |  |
| - Base slab thicknessTS =                                      | 18.0         | сm  |  |
| - HaunchHH =   | 6.0          | cm  |  |
| - Effective base slab widthBS =                                | 228.1        | cm  |  |
| <ul> <li>Distance between fixed points of flangeP =</li> </ul> | <u>490.1</u> | cm. |  |
| - Section and sectional area of steel girder:                  |              |     |  |
|  |              |     |  |

| <ul> <li>Upper flange</li> <li>Web</li> <li>Lower flange</li> </ul> | : | $\frac{3600 \text{ (mm)}}{230 \text{ x}}$ $\frac{230 \text{ x}}{11}$ $\frac{1.550 \text{ x}}{280 \text{ x}}$ $\frac{280 \text{ x}}{11}$ | <u>Sectional Area (cm²)</u><br><u>25.3</u> (SM50Y)<br><u>139.5</u> (SM50Y)<br><u>30.8</u> (SM50Y) |
|---|---|---|---|
| TOTAL   |   |   | <u>195.6</u>  |

- Sectional area and moment of inertia of area:

| and the part of the   | Sectional Area   | Moment of Inertia   |
|---|--|---|
| <ul> <li>Concrete section</li> <li>Steel girder section</li> <li>Composite section</li> </ul> | $\begin{array}{r} (cm^{2})\\ AC = 4.105\\ AS = 195.6\\ AV = 782 \end{array}$ | $\begin{array}{r} \underline{\text{of Ares (cm^{\pm})}} \\ \text{IC} = \underline{110.832} \\ \text{IS} = \underline{620.099} \\ \text{IV} = \underline{1.951.186} \end{array}$ |

- Geometrical moment of area of concrete (AC x DC).....QC = 97,226 cm<sup>3</sup>

- Distance and section modulus (See Fig. 4.4.7):

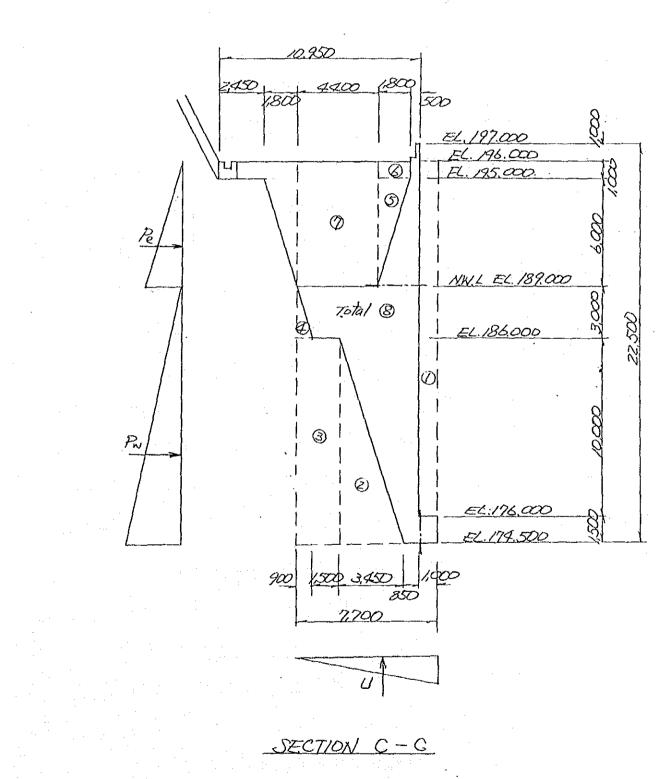
| Distan | <u>ce (cm)</u> | Section Mc | dulus (cm <sup>2</sup> ) |
|--------|----------------|------------|--------------------------|
| D =    | 94.7           | WSU =      | 7,675                    |
| DS ≈   | 71.0           | WSL =      | 8.116                    |
| DC =   | 23.7           | WVU≠       | <u>199.399</u>           |
| YSU =  | 80.8           | WVL=       | 13,236                   |
| YSL =  | 76.4           |            |                          |
| YVU =  | 9.8            |            |                          |
| YVL =  | 147.4          |            |                          |
| YVC =  | 32.7           |            |                          |

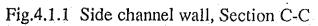
- Axial force

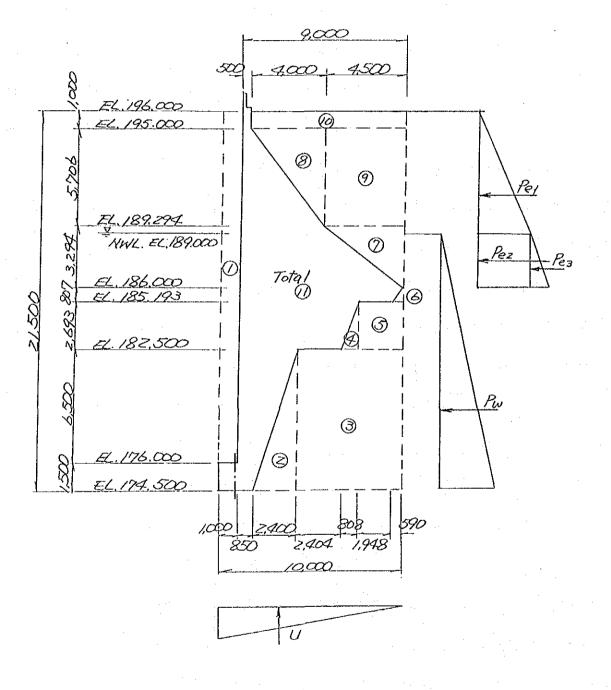
| • Due to drying schrinkageNSH = | 17.1 | ton |
|---------------------------------|------|-----|
| • Due to creepNCR =             | 2.5  | ton |
| Due to temperature changeNTM =  | 12.0 | ton |

- Stress (kg/cm<sup>2</sup>):

|   | Concrete<br>Base Slab | Upper<br>Flange         | Lower<br>Flange       |
|---|-----------------------|-------------------------|-----------------------|
| (1) Stress before compounding                         |                       | - 1,328                 | 1,255                 |
| (2) Stress after compounding                          | - 21.8                | - 46                    | 687                   |
| (3) Stress due to drying schrinkage                   | 3.1                   | - 297                   | 110                   |
| (4) Stress due to creep                               | 1.9                   | - 42                    | 16                    |
| (5) Stress due to temperature difference              | - 0.6                 | - 207                   | 75                    |
| (6) = (1)<br>Allowable stress                         | -<br>-<br>-           | - 1,328                 | <u> </u>              |
| (7) = (1) + (2)<br>Allowable stress                   | - 21.8<br>- 77.1      | - 1.373                 | <u>1.942</u><br>2,100 |
| (8) = (1) + (2) + (3) + (4)<br>Allowable stress       | - 16.8                | <u>-1,712</u><br>-2,415 | 2,068                 |
| (9) = (1) + (2) + (3) + (4) + (5)<br>Allowable stress | - 17.5<br>- 88.7      | - 1.918<br>- 2.730      | 2,144                 |

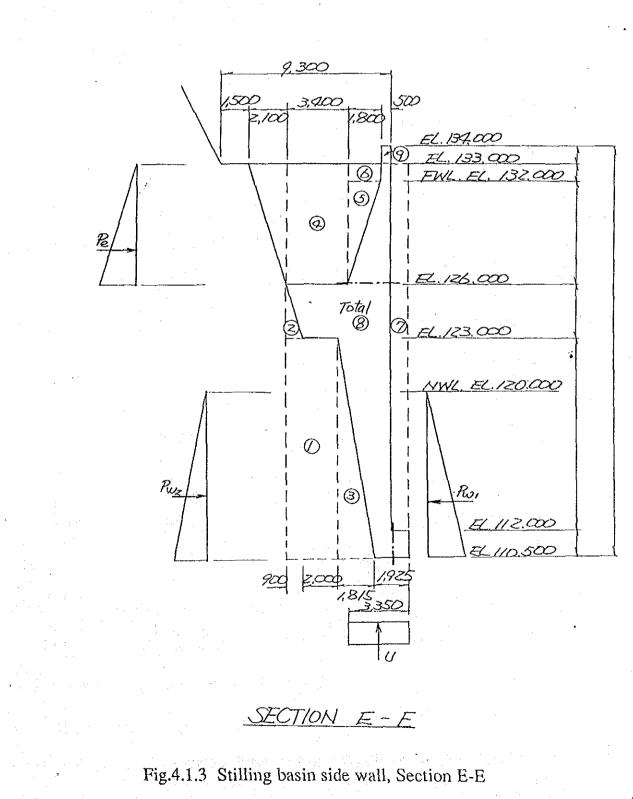


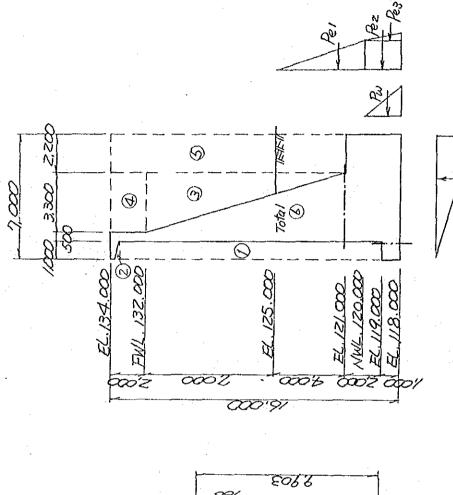


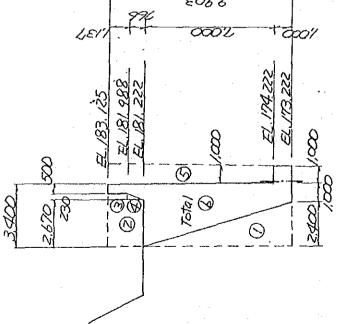


SECTION G-G

Fig.4.1.2 Transition wall, Section G-G

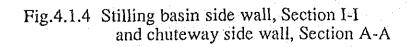


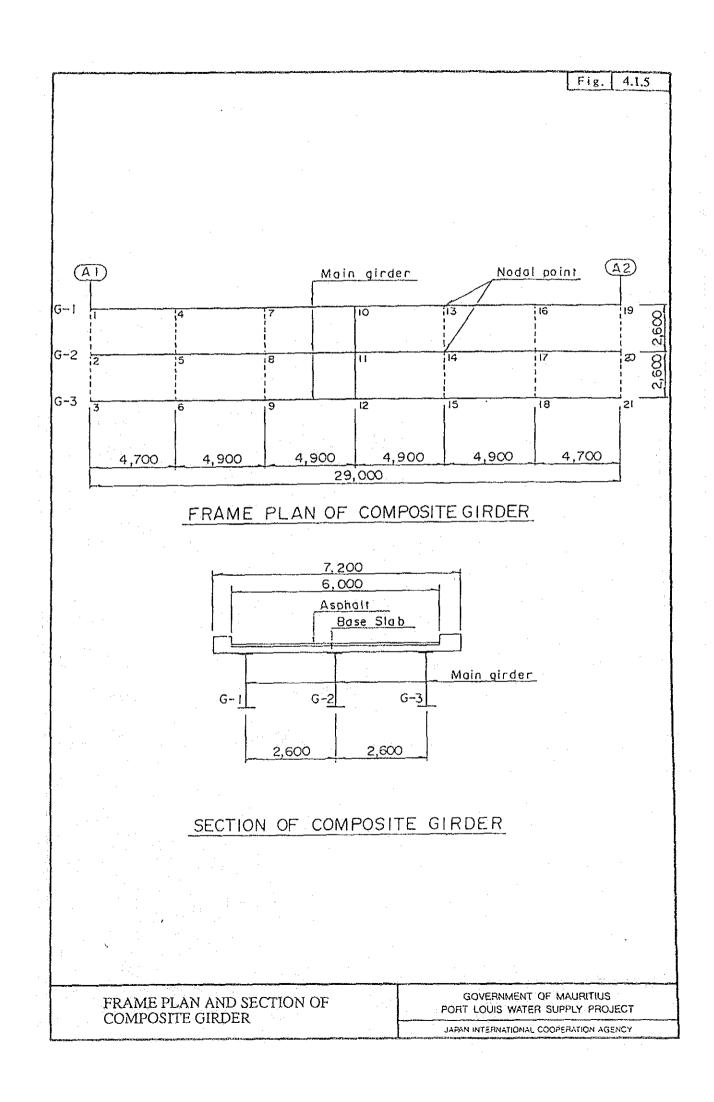


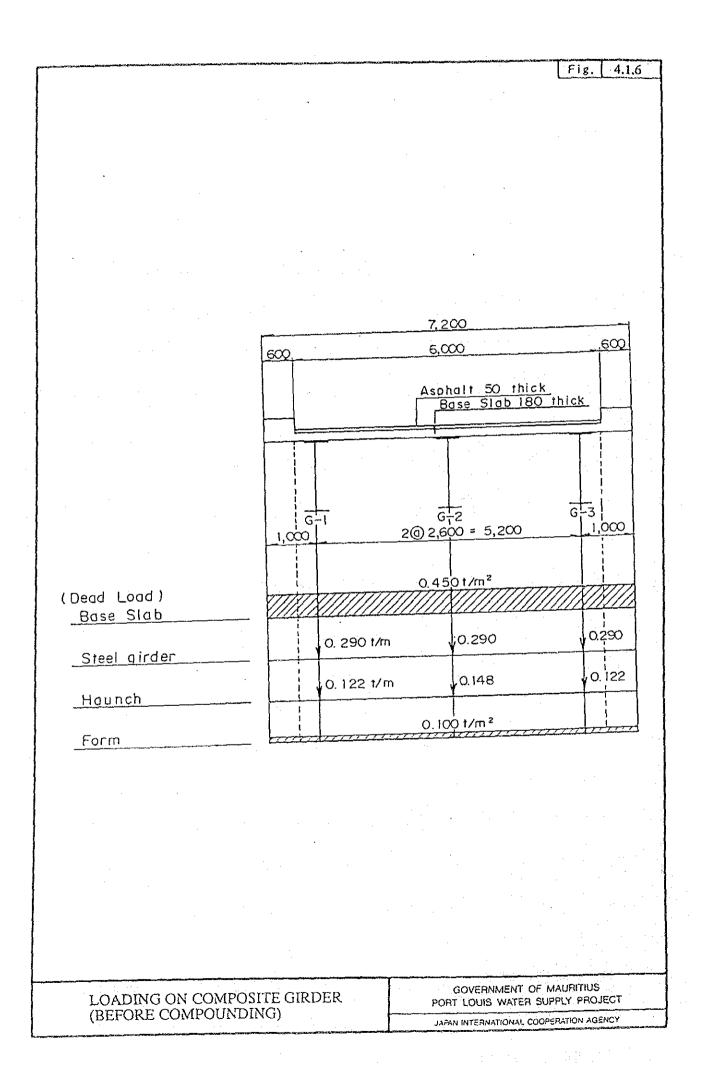


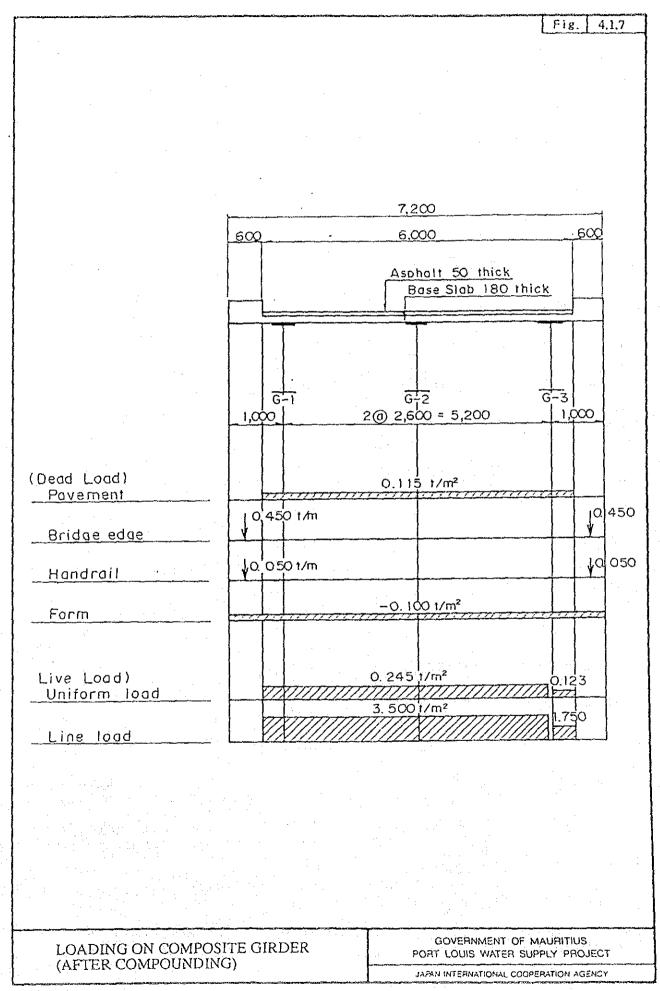
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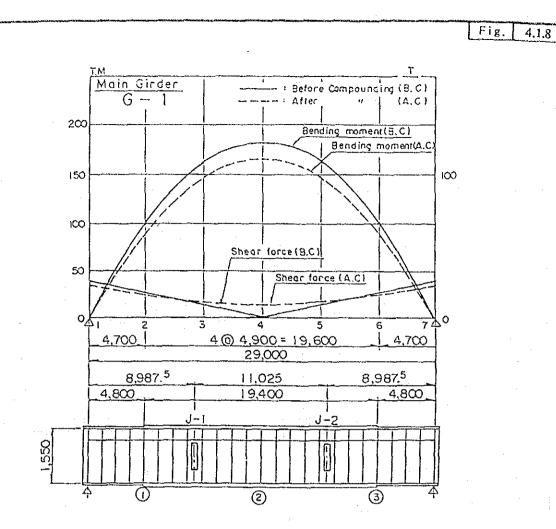
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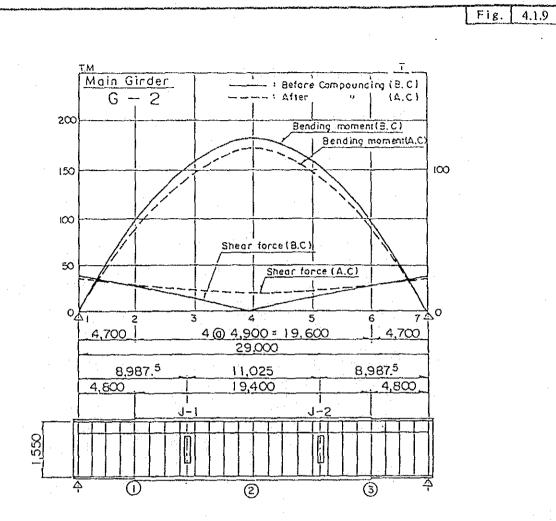




|          |   |              | ·       |       |
|----------|---|--------------|---------|-------|
|          |   | Section Nos. |         |       |
|          |   | 0            | 2       | 3     |
| ITTIC    | В | 230          | 280     | 230   |
| UFLG     | T | 11(3)        | 14 (3)  | 11(3) |
| NUED     | H | 1550         | 1550    | 1550  |
| WEB      | Ť | 9(3)         | 9(3)    | 9(3)  |
| ITC      | B | . 280        | 440     | 280   |
| LFLG     | T | 11(3)        | 19 (3)  | 11(3) |
| SU I     |   | -1327        | -1702   | -1328 |
| SUA I    |   | -1412        | -1765 1 | -1412 |
| SUA-SU i |   | 85 1         | 63 1    | 84    |
| <u>I</u> |   | 2068         | 2055    | 2068  |
| SLA I    |   | 2100         | 2100    | 2100  |
| SLA-SL I |   | 32           | 45 1    | 32    |
| TU !     |   | 239          | 63 1    | 239   |
| TUA      |   | 1200         | 1200    | 1200  |

| UFLG<br>WEB<br>LFLG<br>B<br>H<br>T<br>( ) | : | Upper flange<br>Web<br>Lower flange<br>Width of flange (mm)<br>Height of web (mm)<br>Thickness (mm)<br>Steel material<br>(1): SS41, (2): SM50,<br>(3): SM50Y, (4): SM58 | :<br>SL : | Stress in upper flange (kg/cm <sup>2</sup> )<br>Allowable stress for upper flange<br>(kg/cm <sup>2</sup> )<br>Stress in lower flange (kg/cm <sup>2</sup> )<br>Allowable stress for lower flange<br>(kg/cm <sup>2</sup> )<br>Shearing stress (kg/cm <sup>2</sup> )<br>Allowable shearing stress (kg/cm <sup>2</sup> ) |
|---|---|---|-----------|--|
|   |   | ۵۰٬۰ <u>۰۰ و ۲۰۰۰ و ۲۰۰۰ و ۲۰۰۰ و ۲۰۰۰ و ۲۰۰۰ و ۲۰</u> ۰۰ و ۲۰۰۰  |           |  |

| RESULT OF ANALYSIS ON COMPOSITE GIRDER | GOVERNMENT OF MAURITIUS<br>PORT LOUIS WATER SUPPLY PROJECT |
|--|--|
| (No. 1 Main Girder (G-1))              | JAPAN INTERNATIONAL COOPERATION AGENCY                     |

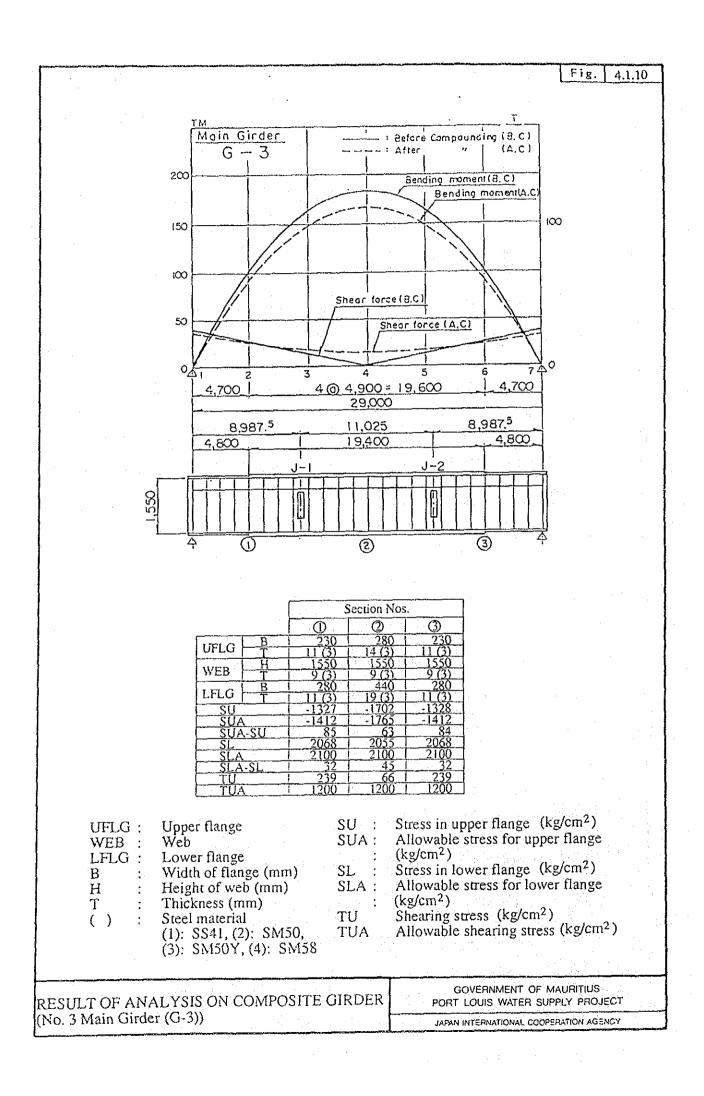


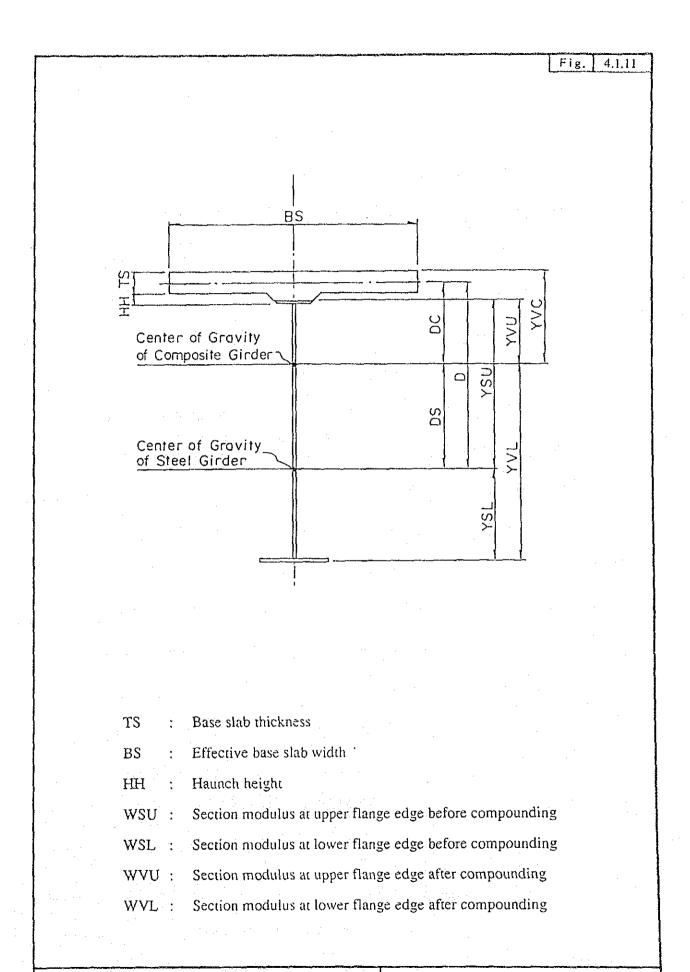
|        | [   | Section Nos.       |         |        |
|--------|-----|--------------------|---------|--------|
|        |     | 0                  | 0       | 3      |
| ITTO   | B   | 230                | 280     | 230    |
| UFLG   | T   | 10 (3)             | 14 (3)  | 10 (3) |
| 11/20  | H   | 1550               | 1550    | 1550_  |
| WEB    | T_I | 9(3)               | 9 (3) 1 | 9(3)   |
| TTO    | B_  | 280 1              | 440     | 280    |
| LFLG   | T   | $\overline{11}(3)$ | 19(3)1  | 11 (3) |
| SU     |     | -1346_1            | -1720   | -1346  |
| SUA    |     | 1379               | 1765    | -1379  |
| SUA-SU |     | 33                 | 45      | 33     |
| SL     |     | 2033 i             | 2066 1  | 2033   |
| SLA    |     | 2100               | 2100    | 2100   |
| SLA-SL |     | 67                 | 34      | 67     |
| TU     |     | 252                | 92      | 252    |
| TUA    |     | 1200               | 1200 1  | 1200   |

| and the second second second second second second second second second second second second second second second | 1. :            | a sa <u>a</u> fa | 0 1 33  |  |
|--|-----------------|------------------|---|--|
| UFLG : Upper f   | lange           | SU :             | Stress in upper flange (kg/cm <sup>2</sup> )    |  |
| WEB : Web  |                 | SUA :            | Allowable stress for upper flange               |  |
| LFLG : Lower f   | lange           |                  | $(kg/cm^2)$                                     |  |
| B : Width o  | of flange (mm)  | SL :             | Stress in lower flange (kg/cm <sup>2</sup> )    |  |
| H : Height of  | of web (mm)     | SLA :            | Allowable stress for lower flange               |  |
| T : Thickne  | ess (mm)        |                  | (kg/cm <sup>2</sup> )                           |  |
| () : Steel m   |                 | TU               | Shearing stress (kg/cm <sup>2</sup> )           |  |
| (1): SS  | 41, (2): SM50,  | TUA              | Allowable shearing stress (kg/cm <sup>2</sup> ) |  |
| (3): SM  | 150Y, (4): SM58 | · · ·            |   |  |
|  |                 |                  |   |  |
| POINT OF ANALYSIS  |                 | GIRDER           | GOVERNMENT OF MAURITIUS                         |  |

RESULT OF ANALYSIS ON COMPOSITE GIRDER (No. 2 Main Girder (G-2))

PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

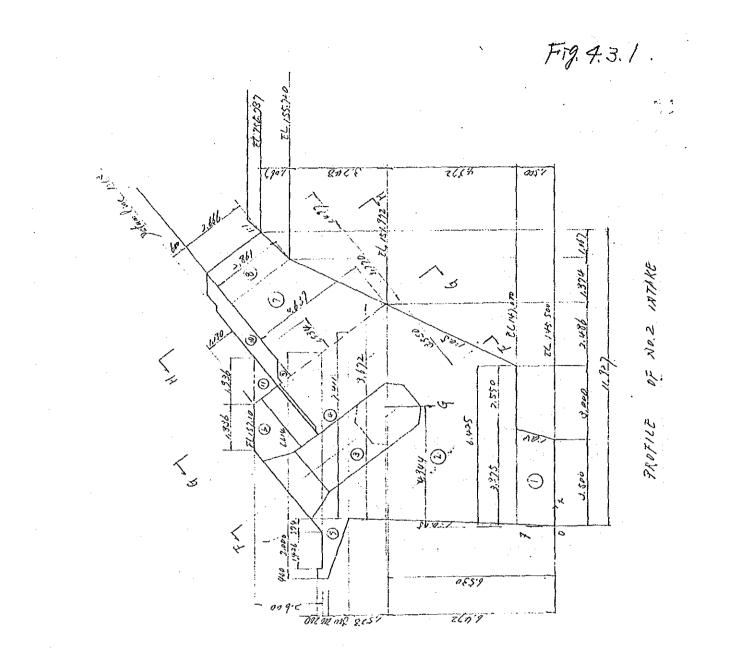


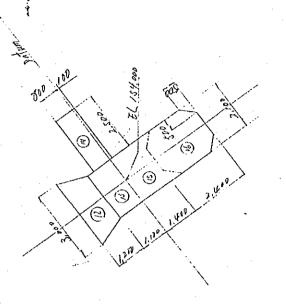


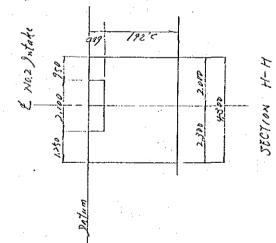
SYMBOLS OF COMPOSITE GIRDER

GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

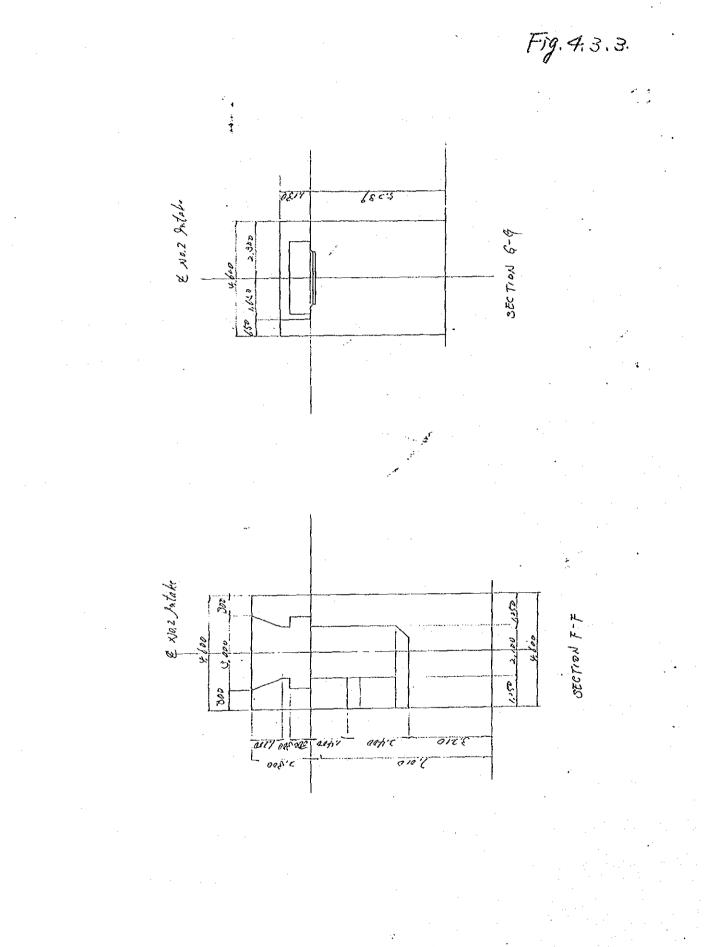






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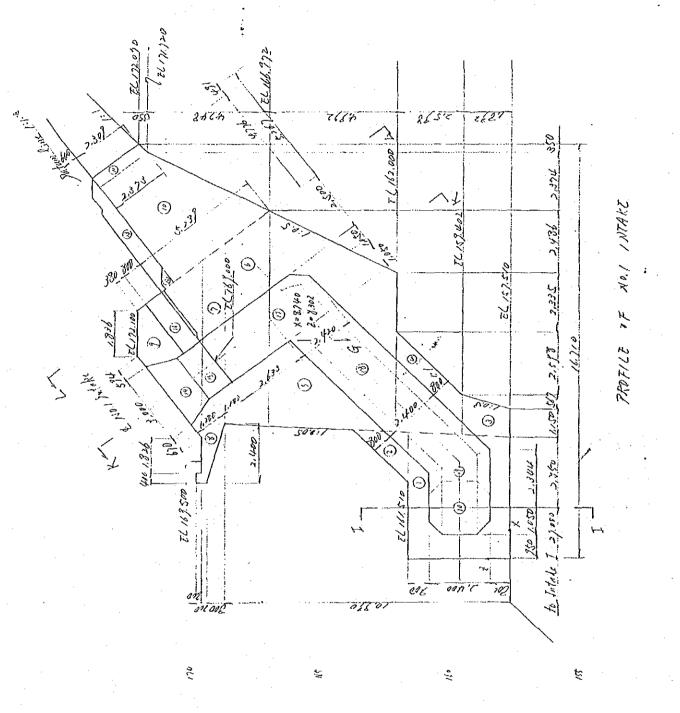
Portion

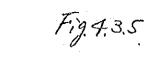


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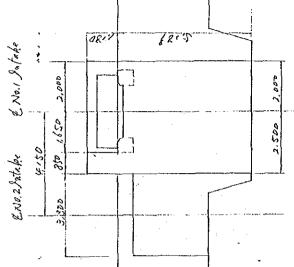
Fig. 4.3.4

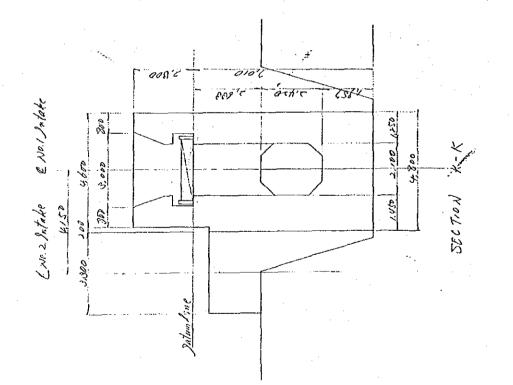




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SECTION





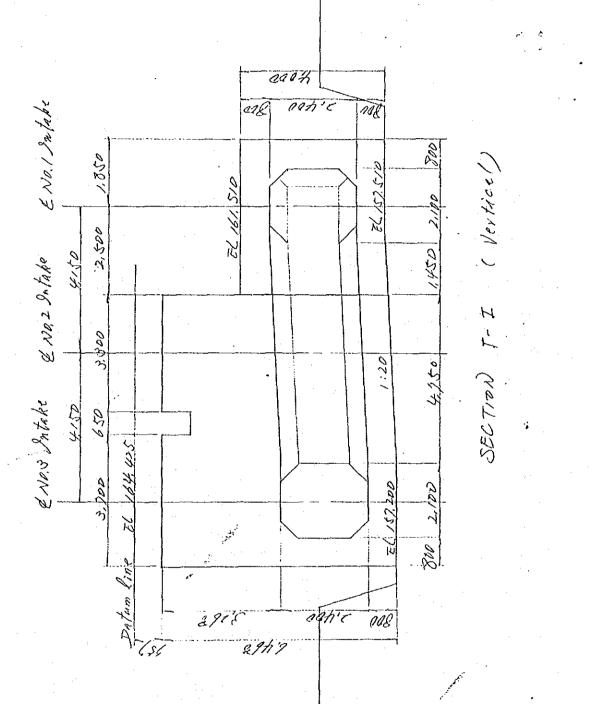
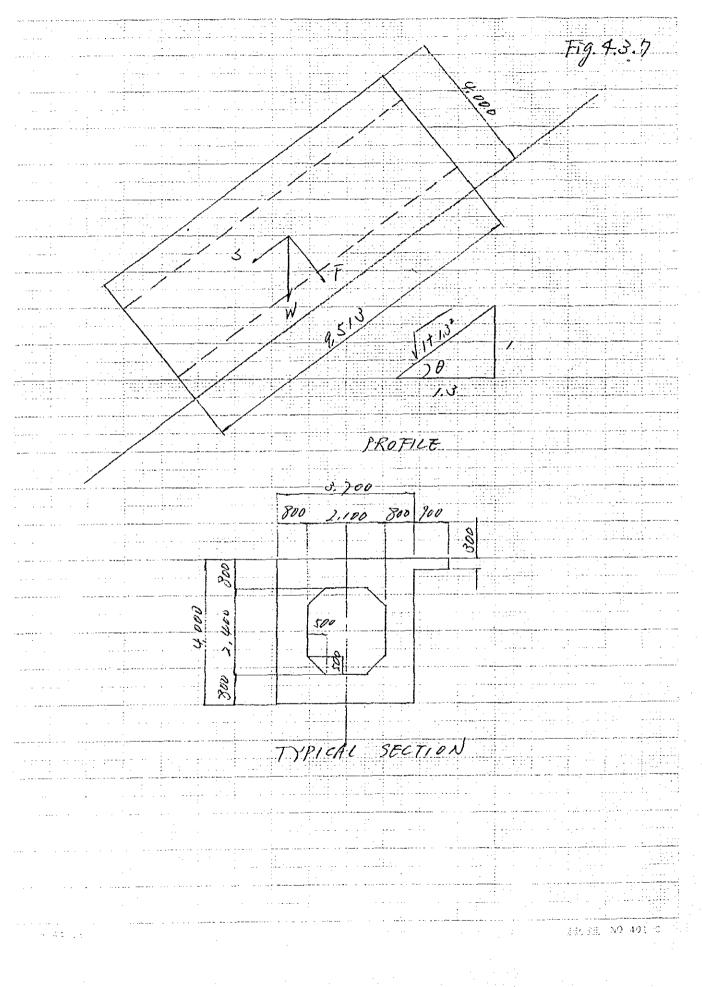
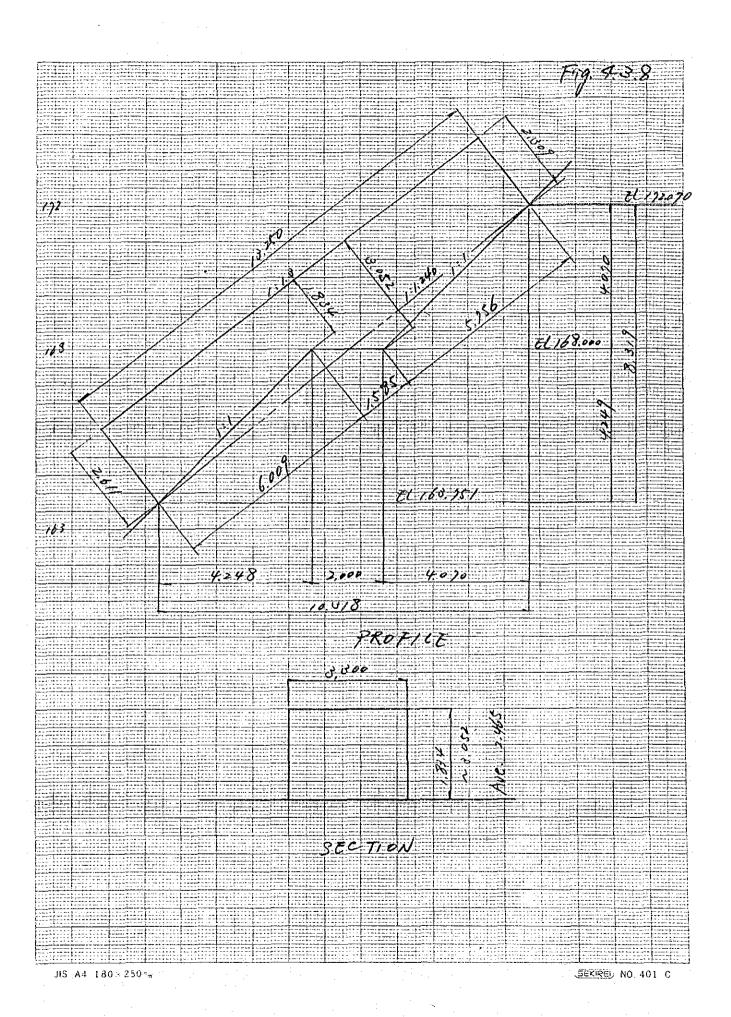
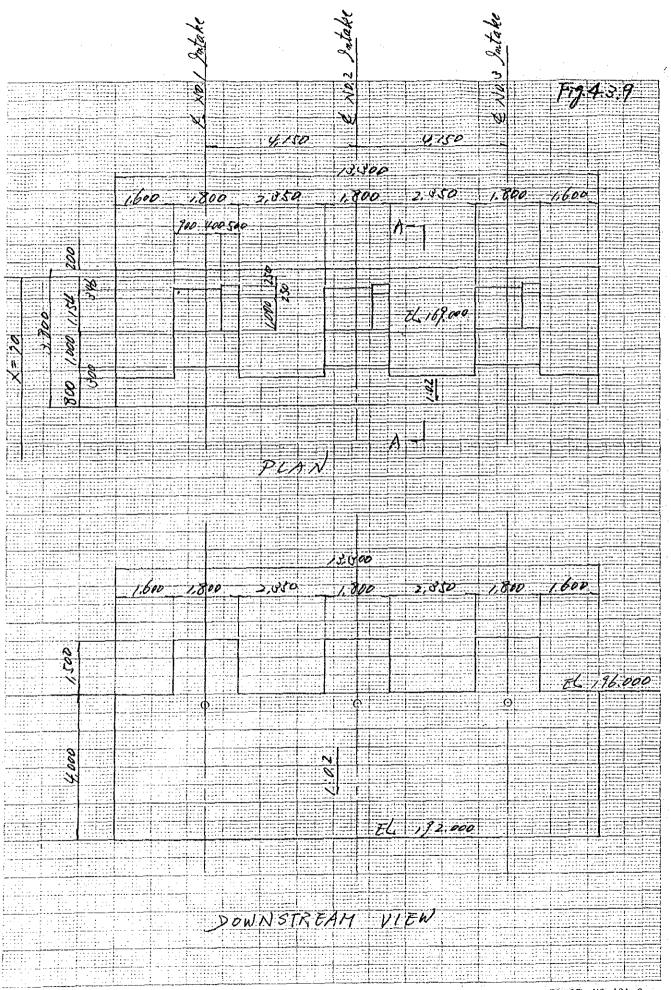


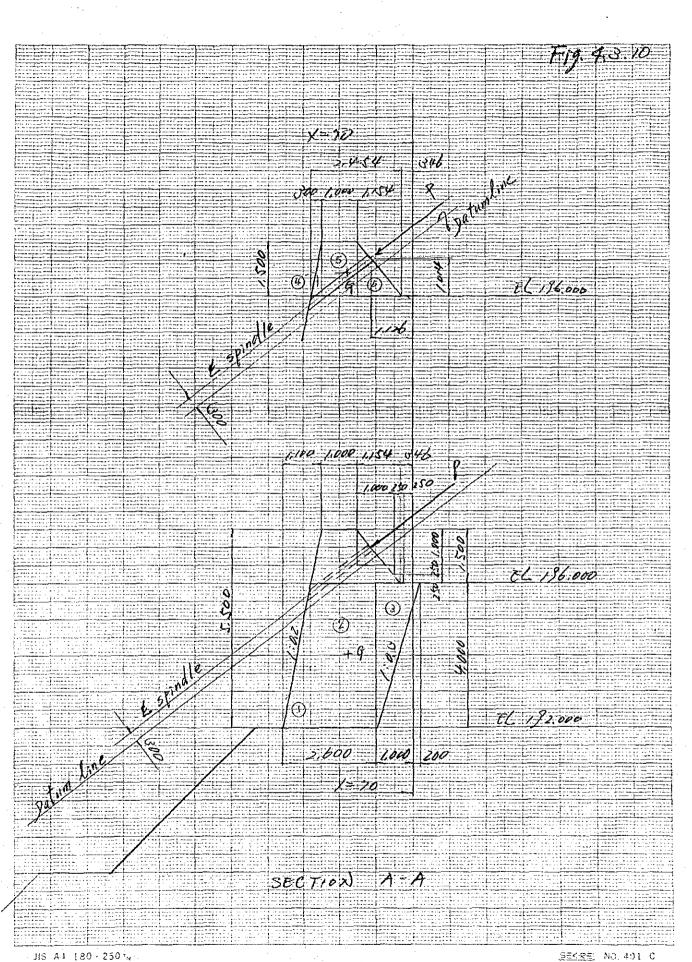
Fig. 4.3.6







SEKIRE NO. 401 C



# PART V STRESS CALCULATION

## PART V. STRESS CALCULATION

## 5.1 Main Dam Gallery

## 5.1.1 Design Sections

Dimensions of the design section of the gallery are as shown in Fig. 5.1.1.

5.1.2 Design Values

(1) Unit weight

| Reinforced concrete        | $r_c = 2.40 t/m^3$                              |
|----------------------------|---|
| Water                      | $r_{w} = 1.0 \text{ t/m}^{3}$                   |
| Core material (embankment) | $r_{wet} = 1.80 t/m^3$ (wet condition)          |
| · · ·                      | $r_{sat} = 1.72 \text{ t/m}^3$ (saturated con.) |

(2) Elastic modulus and Poisson's ratio

| :        | Elastic modulus (t/m <sup>2</sup> ) | Poisson's ratio |
|----------|-------------------------------------|-----------------|
| Concrete | 2.55 x 10 <sup>6</sup>              | 0.2             |
| Rock     | 5.5 x 10 <sup>5</sup>               | 0.3             |

(3) Allowable stress

| •         | Compression           | Tension                  | Shearing                 |
|-----------|-----------------------|--------------------------|--------------------------|
| Concrete  | 70 kg/cm <sup>2</sup> | $0 \text{ kg/cm}^2$      | $8 \text{ kg/cm}^2$      |
| Steel bar | •<br>•                | 1,800 kg/cm <sup>2</sup> | 1,800 kg/cm <sup>2</sup> |

## 5.1.3 Loading Conditions

It is schemed that the height of the dam will be risen when water demand increase in future. Accordingly structure analyses are carried out in the condition that the dam is filled up to the final crest elevation of EL, 215.0 m.

Under the above fill, the following two loading cases are adopted as design load conditions. (See Fig. 5.1.2)

| Load case 1: | Reservoir water is at FWL (=212.5 m) without uplift   |
|--------------|---|
| Load case 2: | Reservoir water is at FWL (=212.5 m) with full uplift |

The loads are calculated as follows:

Load case 1

p1 = (212.5 - 112) x 1.80 t/m<sup>3</sup> = 180.9 t/m<sup>2</sup> p2 = (215 - 212.5) x 1.72 t/m<sup>3</sup> = 4.3 t/m<sup>2</sup>

Load case 2

 $p1 = (212.5 - 112) \times 1.80 \text{ t/m}^3 = 180.9 \text{ t/m}^2$   $p2 = (215 - 212.5) \times 1.72 \text{ t/m}^3 = 4.3 \text{ t/m}^2$   $p3 = (212.5 - 112) \times 1.0 \text{ t/m}^3 = 100.5 \text{ t/m}^2$  $p4 = \{212.5 - (112 - 4.4)\} \times 1.0 \text{ t/m}^3 = 104.9 \text{ t/m}^2$ 

#### 5.1.4 Stress Analysis

Stress analyses on the design section are carried out by a finite element method. A computer FEM programme C-143 registered in Nippon Koei is used.

A mesh model and boundary conditions of the model are as shown in Fig. 5.1.3.

#### 5.1.5 Results of FEM Analysis

Compressive/tensile stress in horizontal and vertical directions, shear stress and principle stress in every element in the model are given in Table 5.1.1 and 5.1.2. The compressive/tensile stress and shear stress which are required for design of reinforcement bar arrangement are extracted from these tables and put down in the relevant elements in the design section, as shown in Fig. 5.1.4 and 5.1.5.

From these tables and figures, the followings are noticeable.

(1) A maximum compressive stress in the design section is low enough for the allowable compressive stress of concrete (=70 kg/cm<sup>2</sup>). The maximum value in each loading conditions is as listed below.

|             |                  | (Office Regional) |
|-------------|------------------|-------------------|
|             | X-direction      | Y-direction       |
| Load case 1 | 23.0 Element 279 | 53.0 Element 164  |
| Load case 2 | 38.8 Element 146 | 54.3 Element 164  |

There are some elements where tensile stress occurs in both loading conditions. The tensile stress in load case 1 is larger than load case 2, in comparison with both conditions. Reinforcement bars against these tensile stress are required consequently.

(Think tradam?)

From this table, it is noticed that

(2)

(3)

- load case 2 is severer loading condition in shear stress, and
- the average shear stress at Line <sup>(5)</sup>, <sup>(8)</sup>, and <sup>(9)</sup> are larger than the allowable shear stress of concrete without stirrups (=8.5 kg/cm<sup>2</sup>) but below the allowable shear stress with stirrups (=19 kg/cm<sup>2</sup>) according to Standard Specification for Design and Construction of Concrete Structures 1986 Part 1, JSCE Clause 14.3.

Consequently, stirrups are required for these shear stresses.

## 5.1.6 Reinforcement Bars

(1) Re-bars for tensile stress

A required area at rc-bars against tensile stress is calculated with the following formula.

 $As = \frac{\text{Total tensile strength in 1m depth (kg)}}{\text{Allowable tensile stress in re-bar (kg/cm<sup>2</sup>)}}$ 

i) At the center of the upper slab (Line  $\oplus$  -  $\oplus$  in Fig. 5.1.4)

As = 
$$\frac{\frac{1}{2} \times 6 \text{ kg/cm}^2 \times 35 \text{ cm} \times 100 \text{ cm}}{1,800 \text{ kg/cm}^2}$$
  
= 5.8 cm<sup>2</sup>

V-3

ii) At the Line @ - @ in Fig. 5.1.5, where the largest tensile stress occur in the upper part of the slab

As = 
$$\frac{\frac{1}{2} \times 14 \text{ kg/cm}^2 \times 90 \text{ cm} \times 100 \text{ cm}}{1,800 \text{ kg/cm}^2}$$
  
=  $3.5 \text{ cm}^2 \rightarrow D29 @150 = 42.9 \text{ cm}^2$ 

iii) At the center of the invert slab

As = 
$$\frac{\frac{1}{2} \times 6 \text{ kg/cm}^2 \times 30 \text{ cm} \times 100 \text{ cm}}{1,800 \text{ kg/cm}^2}$$
  
= 4.9 cm<sup>2</sup>

(2) Min. reinforcement bars

The above standard (by JSCE), Clause 6.2.3, specifies a minimum area of tensile reinforcement bars of 0.2% for the concrete area.

According to this, a minimum area of re-bar at Line (1) and (3) is calculated as follows:

i) Line ① - ①

As  $\geq$  130 cm x 100 cm x 0.2/100 = 26 cm<sup>2</sup>  $\rightarrow$  D25 @150 = 33.8 cm<sup>2</sup>

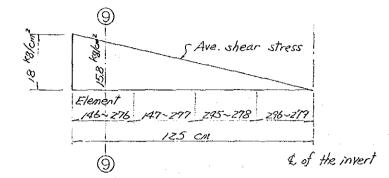
As  $\geq$  150 cm x 100 cm x 0.2/100 = 30 cm<sup>2</sup>  $\rightarrow$  D25 @150 = 33.8 cm<sup>2</sup>

# (3) Stirrups

i) Line ⑨ - ⑨

- Shear stress distribution is as shown below.

: V - 4



A total shear stress is:

 $S = 0.5 \times 18 \text{ kg/cm}^2 \times 100 \text{ cm} \times 125 \text{ cm}$  $= 1,125 \text{ kg/cm}^2$ 

Required area of stirrups

 $As = (S x t)/(1,800 \text{ kg/cm}^2 x \text{ jd})$ 

 $= 1,125 \times \frac{30}{(1,800 \times 150 \times 2/3)}$ 

 $= 0.19 \text{ cm}^2 \rightarrow \emptyset 13 \ (= 1.327 \text{ cm}^2)$ 

where; t : jd :

spacing at stirrups (cm)
distance from compression resultant to centroid of tension reinforcement (m)

Pitch of the stirrups  $\geq$  D25 x 15 = 375 cm or  $\emptyset 13 x 48 = 624$  cm or 130/2 = 65 cm  $\rightarrow 350$  cm

ii) Line (5) and (8)

The shear stress at Line is smaller than Line . Accordingly the same stirrup arrangement in the invert slab as given above is made.

(4) Surface crack prevention re-bars

(5)

For prevention of surface cracks, D22 @300 is arranged.

From the above  $(1) \sim (4)$ , a reinforcement bar arrangement is made as shown in Fig. 5.1.6

5.2 Spillway

# 5.2.1 Wall Section C-C

(1) Case I

1) EL. 189.000 m

| Shearing force - earth P. | $Qe = 1.93 \times 7^2 \times \frac{1}{2} \times 0.241$ | = | 11.40 t |
|---------------------------|--|---|---------|
|                           |  |   |         |

| Bending moment |                         | 1             |
|----------------|-------------------------|---------------|
| - earth P.     | $Me = 11.40 \times 7/3$ | <br>26.60 t.m |

2) Tœ

| Shearing force |                                 |   |   |         |
|----------------|---------------------------------|---|---|---------|
| - reaction     | $Qr = 23.06 \times 1.0$         |   |   | 23.06 t |
| - concrete     | $Qc = -1 \times 1.5 \times 2.4$ |   | = | -3.60 t |
| - uplift       | Qu = 14.5 x 1.0                 |   | = | 14.50 t |
| 1              |                                 | Q | = | 33.96 t |

| <ul> <li>Bending momer</li> </ul> | nt                                 |   |   |           |   |
|-----------------------------------|------------------------------------|---|---|-----------|---|
| - reaction                        | Mr = 23.06 x 1.0/2                 |   | = | 11.53 t.m |   |
| - concrete                        | $Mc = -3.6 \times 1.0 \times 1/2$  |   | = | -1.80 t.m |   |
| - uplift                          | $Mu = 14.50 \times 1.0 \times 1/2$ |   | = | 7.25 t.m  | - |
| •                                 |                                    | М | = | 16.98 t.m |   |

(2) Case II

1) EL. 189.000 m

| Shearing force |   |       |         |
|----------------|---|-------|---------|
| - earth P.     | $Qe = 11.40 \times 1.05$                      |       | 11.97 t |
|                | $Qe = 1.8 \times 1.0 \times 1.93 \times 0.05$ | =     | 0.17 t  |
|                | Qe = 1.8 x 6 x 1/2 x 1.93 x 0.05              | =     | 0.52 t  |
| - concrete     | $Qc_1 = 0.48 \times 0.05$                     | =     | 0.02 t  |
|                | $Qc_2 = 1.2 \times 0.05$                      | . = . | 0.06 t  |
|                | $Qc_3 = 17.2 \times 0.05$                     | - =   | 0.36 t  |

|                | $Qc_4 = 12.96 \times 0.05$      |          | =   | 0.65 t    |
|----------------|---------------------------------|----------|-----|-----------|
|                |                                 | Q        | =   | 13.75 t   |
| Bending moment |                                 |          |     |           |
| - earth P.     | Me = 11.97 x 7/3                |          | =   | 27.93 t.m |
|                | Me = 0.17  x (6.0 + 0.5)        |          | =   | 1.01 t.m  |
|                | Me = 0.52 x 6 x 2/3             |          | =   | 2.08 t.m  |
| - concrete     | $Mc_1 = 0.02 \times (7 + 0.5)$  |          | =   | 0.15 t.m  |
|                | $Mc_2 = 0.06 \times (6 + 0.5)$  |          | ÷   | 0.39 t.m  |
|                | $Mc_3 = 0.36 \times 3$          |          | =   | 1.08 t.m  |
|                | Mc4 = 0.65 x 6/3                |          | ==  | 1.30 t.m  |
|                |                                 | М        | 13  | 33.94 t.m |
|                |                                 |          |     |           |
| Tœ             |                                 |          |     |           |
|                |                                 |          |     |           |
| Shearing force |                                 | *        |     |           |
| - reaction     | $Qr = 23.06 \times 1.0$         |          | Ħ   | 23.06 t   |
| - concrete     | $Qc = -1 \times 1.5 \times 2.4$ |          | 11  | -3.60 t   |
| - uplift       | $Qu = 14.5 \times 1.0$          | <u> </u> | Ξ   | 14.50 t   |
|                |                                 | Q        | IR  | 33.96 t   |
|                |                                 |          |     |           |
| Bending moment |                                 |          |     |           |
| - reaction     | $Mr = 23.06 \times 1.0/2$       |          | _ = | 11.53 t.m |
| - concrete     | $Mc = -3.6 \times 1.0/2$        |          | =   | -1.80 t.m |
| - uplift       | $Mu = 14.50 \times 1.0/2$       | ······   | =   | 7.25 t.m  |
|                |                                 | М        | =   | 16.98 t.m |
|                |                                 |          |     |           |
|                |                                 |          |     |           |

5.2.2 Wall Section G-G

(1) Case I and II

2)

1) Toe

| Shearing force |                                   | ·                                     |       |         |  |
|----------------|-----------------------------------|---------------------------------------|-------|---------|--|
| - reaction     | $Qr = 22.0 \times 1.0$            |                                       | • = • | 22.00 t |  |
| - concrete     | $Qc = -1.5 \times 1.0 \times 2.4$ |                                       | =     | -3.60 t |  |
| - uplift       | $Qu = 14.5 \times 1.0$            | · · · · · · · · · · · · · · · · · · · | =     | 14.50 t |  |
|                | · · ·                             | Q                                     | =     | 32.90 t |  |

V-7

| Bending moment |                           |   |   |    |           |
|----------------|---------------------------|---|---|----|-----------|
| - reaction     | $Mr = 22.00 \times 1.0/2$ |   |   | 11 | 11.00 t.m |
| - concrete     | $Mc = -3.6 \times 1.0/2$  |   |   | æ  | -1.80 t.m |
| - uplift       | Mu = 14.50 x 1.0/2        | - |   | =  | 7.25 t.m  |
| -              |                           |   | М | 11 | 16.45 t.m |

## 5.2.3 Wall Section A-A

(1) Case II

1) Toe

| Shearing force |                           | · · · · · |   |           |  |
|----------------|---------------------------|-----------|---|-----------|--|
| - reaction     | $Qr = 13.1 \times 1.0$    |           | = | 13.10 t   |  |
| - concrete     | $Qc = 1.0^2 x - 2.4$      |           |   | -2.40 t   |  |
|                | •<br>•                    | Q         | = | 10.70 t   |  |
|                |                           |           |   |           |  |
| Bending moment |                           |           |   |           |  |
| - reaction     | $Mr = 13.10 \times 1.0/2$ |           | = | 6.55 t.m  |  |
| - concrete     | $Mc = -2.40 \times 1.0/2$ |           | = | -1.20 t.m |  |
|                |                           | M         | = | 5.35 t.m  |  |

# 5.2.4 Wall Section E-E

(1) Case I

1) EL. 126.000 m

Shearing force - earth P.  $Qe = 1.93 \times 7^2 \times \frac{1}{2} \times 0.241$ 

11.40 t

==

=

Bending moment - earth P.  $Me = 11.40 \times 7 \times \frac{1}{3}$ 

26.60 t.m

2) Tœ

Shearing force

| - reaction     | $Qr = 24.10 \times 1.0$           |   |   | =  | 24.10 t |  |
|----------------|-----------------------------------|---|---|----|---------|--|
| - concrete     | $Qc = -1.0 \times 1.5 \times 2.4$ |   |   | := | -3.60 t |  |
| - water        | $Qw = -1.0 \times 8.0 \times 1.0$ |   |   | :: | -8.00 t |  |
| - uplift       | $Qu = 12.5 \times 1.0$            | _ |   | =  | 12.50 t |  |
|                |                                   |   | Q | ×  | 25.00 t |  |
|                |                                   |   |   |    |         |  |
| Bending moment |                                   |   |   |    |         |  |

| 0          |                           |   |   |           |  |
|------------|---------------------------|---|---|-----------|--|
| - reaction | $Mr = 24.10 \times 1.0/2$ |   | = | 12.05 t.m |  |
| - concrete | $Mc = -3.6 \times 1.0/2$  |   | = | -1.80 t.m |  |
| - water    | $Mw = -8.0 \times 1.0/2$  |   | = | -4.0 t.m  |  |
| - uplift   | Mu = 12.50 x 1.0/2        |   | = | 6.25 t.m  |  |
|            |                           | М | = | 12.50 t.m |  |

(2)

Case II

1)

EL. 126.000 m

Shearing force  $Qe = 11.40 \times 1.05$ 11.97 t - earth P. Ξ  $Qe = 1.8 \times 1.0 \times 1.93 \times 0.05$ 0.17 t =  $Qe = 1.8 \times 6 \times 1/2 \times 1.93 \times 0.05$ 0.52 t ₽  $Qc = 22.56 \times 0.05$ 1.128 t = - concrete Q = 13.79 t Bending moment

| ¢          |   |   |      |           |
|------------|---|---|------|-----------|
| - earth P. | $Me = 11.97 \times 7 \times 1/3$        |   | =    | 27.93 t.m |
|            | $Me = 0.17 \times (0.5 + 6.0)$          |   | =    | 1.11 t.m  |
| · .        | $Me = 0.52 \times 6 \times 2/3$         |   | =    | 2.08 t.m  |
| - concrete | $Mc = 2.4 \times 0.05 \times (1 + 6.0)$ |   | =    | 0.84 t.m  |
|            | $Mc = 7.2 \times 0.05 \times 6/2$       |   | =    | 1.08 t.m  |
|            | $Mc = 12.96 \times 0.05 \times 6/3$     |   | · == | 1.30 t.m  |
|            |   | м |      | 2121 +    |

V - 9

М 34.34 t.m ≂

2) Tœ

Shearing force

| -              |                                   |   |    |           |
|----------------|-----------------------------------|---|----|-----------|
| - reaction     | Qr = 24.10  x  1.0                | ÷ | =  | 24.10 t   |
| - concrete     | $Qc = -1.0 \times 1.5 \times 2.4$ |   | =  | -3.60 t   |
| - water        | $Qw = -1.0 \times 8.0 \times 1.0$ |   | == | -8.00 t   |
| - uplift       | $Qu = 12.5 \times 1.0$            |   | =  | 12.50 t   |
|                |                                   | Q | ¥  | 25.00 t   |
|                |                                   |   |    |           |
| Bending moment |                                   |   |    |           |
| maction        | $Mr = 24.10 \times 1.0/2$         |   | =  | 12.05 t.m |

| ·          |                           | M | = | 12.50 t.m  |  |
|------------|---------------------------|---|---|------------|--|
| - uplift   | $Mu = 12.50 \times 1.0/2$ |   | = | 6.25 t.m   |  |
| - water    | Mw = -8.0 x 1.0/2         |   | = | -4.0 t.m   |  |
| - concrete | $Mc = -3.6 \times 1.0/2$  |   | = | -1.80 t.m  |  |
| - leaction | WII - 24.10 X 1.0/2       |   |   | 10100 1011 |  |

(3) Case III

> EL. 126.000 m 1)

| Shearing force<br>- carth P. | Qe = 1.93 x $7^2$ x $\frac{1}{2}$ x 0.241 | = | 11.40 t   |
|------------------------------|---|---|-----------|
| Bending moment - earth P.    | Me = 11.40 x 7x $\frac{1}{3}$             | = | 26.60 t.m |

2) Tœ

Shearing force

| - reaction | $Qr = 19.7 \times 1.0$   |   | =   | 19.70 t |
|------------|--|---|-----|---------|
| - concrete | $Qc = -1.0 \times 1.5 \times 2.4$  |   | Ħ   | -3.60 t |
| - water    | $Qw = -1.0 \times 8.0 \times 1.0$  |   | . = | -8.00 t |
| - uplift   | $Qu = 15.5 \times 1.0$   |   |     | 15.50 t |
| -          | and Alexandrian Control of Contro | Q | =   | 23.60 t |
|            |  |   |     |         |

| Bending momen | t set set                |       |          |  |
|---------------|--------------------------|-------|----------|--|
| - reaction    | Mr = 19.7 x 1.0/2        | =     | 9.85 t.m |  |
| - concrete    | $Mc = -3.6 \times 1.0/2$ | =     | -1.8 t.m |  |
| - water       | Mw = -8.0 x 1.0/2        | -<br> | -4.0 t.m |  |

| - uplift                  | Mu = 15.50 x 1.0/2  |  | =   | 7.75 t.m                                |
|---------------------------|---|--|---|---|
|                           |   | М  | =   | 11,80 t.m                               |
|                           |   |  |   |   |
|                           |   |  |   |   |
| Il Section I-I            |   |  |   |   |
|                           |   |  |   | ·.                                      |
| EL. 121.000 m             |   |  |   |   |
| Shearing force            |   |  |   |   |
| - carth P.                | $Qe = 0.241 \text{ x } 1.93 \text{ x } 4.0^2 \text{ x } \frac{1}{2}$  |  | =   | 3.72 t                                  |
|                           |   |  |   | ۰.                                      |
| Bending moment - earth P. | Me = $3.72 \times \frac{4}{3}$  |  | =   | 4.96 t.m                                |
|                           |   |  |   |   |
| Tœ                        |   |  |   |   |
| Shearing force            |   |  |   |   |
| -                         | $Or = (22.40 + 20.93)/2 \times 1.0$   |  | =   | 21.67 t                                 |
|                           |   |  | =   | -2.40 t                                 |
|                           |   |  | =   | 0.15 t                                  |
| •                         | · · · ·   | Q  | -   | 19.42 t                                 |
| · · ·                     |   |  |   |   |
| Bending moment            |   |  |   |   |
| - reaction                | Mr = 20.93 x 1.0 x 1.0/2 +  |  |   |   |
| · ·                       | 1.47 x 1.0/2 x 1.0 x 2/3  |  | _ =   | 10.96 t.m                               |
| - concrete                | $Mc = -2.4 \times 1.0/2$  |  | =   | -1.20 t.m                               |
| - uplift                  | Mu = 0.15 x 1.0/3   |  | =   | 0.05 t.m                                |
|                           |   | Μ  | =   | 9.81 t.m                                |
|                           |   |  |   |   |
| [                         |   |  |   |   |
| FI 121 000 m              |   |  |   |   |
| L/L, 141.000 III          |   |  |   |   |
| Shearing force            |   |  |   |   |
| - earth P.                | $Qe = 3.72 \times 1.05$   | •  | =   | 3.91 t                                  |
|                           | $Qe = 4.632 \times 0.05$  |  |   |   |
|                           | <ul> <li>I Section I-I</li> <li>EL. 121.000 m</li> <li>Shearing force <ul> <li>carth P.</li> </ul> </li> <li>Bending moment</li> <li>earth P.</li> </ul> <li>Toe <ul> <li>Shearing force</li> <li>reaction</li> <li>concrete</li> <li>uplift</li> </ul> </li> <li>Bending moment <ul> <li>concrete</li> <li>uplift</li> </ul> </li> <li>Bending moment <ul> <li>concrete</li> <li>uplift</li> </ul> </li> <li>Bending moment <ul> <li>concrete</li> <li>uplift</li> </ul> </li> <li>Bending moment <ul> <li>concrete</li> <li>uplift</li> </ul> </li> | II Section I-I         EL. 121.000 m         Shearing force         - carth P.       Qe = $0.241 \times 1.93 \times 4.0^2 \times \frac{1}{2}$ Bending moment         - earth P.       Me = $3.72 \times \frac{4}{3}$ Toe         Shearing force         - reaction       Qr = $(22.40 + 20.93)/2 \times 1.0$ - concrete       Qc = $-1.0 \times 1.0 \times 2.4$ - uplift       Qu = $0.29 \times 1.0/2$ Bending moment       -         - reaction       Mr = $20.93 \times 1.0 \times 1.0/2$ - concrete       Mc = $-2.4 \times 1.0/2$ - uplift       Mu = $0.15 \times 1.0/3$ | M<br>Il Section I-I<br>EL. 121.000 m<br>Shearing force<br>- carth P. $Qe = 0.241 \times 1.93 \times 4.0^2 \times \frac{1}{2}$<br>Bending moment<br>- earth P. $Me = 3.72 \times \frac{4}{3}$<br>Toe<br>Shearing force<br>- reaction $Qr = (22.40 + 20.93)/2 \times 1.0$<br>- concrete $Qc = -1.0 \times 1.0 \times 2.4$<br>- uplift $Qu = 0.29 \times 1.0/2$<br>Bending moment<br>- reaction $Mr = 20.93 \times 1.0 \times 1.0/2 + 1.47 \times 1.0/2 \times 1.0 \times 2/3$<br>- concrete $Mc = -2.4 \times 1.0/2$<br>- uplift $Mu = 0.15 \times 1.0/3$<br>M<br>EL. 121.000 m<br>Shearing force | M = M = M = M = M = M = M = M = M = M = |

. . . . . . . . .

| - concrete   | $Qc = 66.48 \times 0.05$   |     |          | <u>3.32 t</u>  |
|--|--|-----|----------|--|
|  |  | Q   |          | 7.46 t   |
|  |  |     |          |  |
| Bending moment   |  |     |          |  |
| - earth P.   | $Me = 3.91 \times 4 \times 1/3$  |     | =        | 5.21 t.m   |
|  | $Me = 0.23 \times 4 \times 2/3$  |     | a        | 0.61 t.m <sup>2</sup>                                  |
| - concrete   | $Mc = 7.2 \times 0.05 \times (0.1 + 12.8)$   |     | u        | 4.64 t.m   |
|  | $Mc = 0.36 \times 0.05 \times (0.2 + 12.5)$  |     | =        | 0.23 t.m   |
|  | $Mc = 0.36 \times 0.05 \times (0.15 + 12.5)$   |     | Ħ        | 0.23 t.m   |
|  | $Mc = 1.80 \times 0.05 \times (1.5 \times \frac{1}{2} + 11).$  | 0)  | =        | 1.06 t.m   |
|  | $Mc = 3.2 \times 0.05 \times 11 \times \frac{1}{2}$  | :   | =        | 3.63 t.m   |
|  | $Mc = 43.56 \times 0.05 \times 11 \times \frac{1}{3}$  | · . | <b>=</b> | 7.99 t.m   |
|  | · • • • • • • • • • • • • • • • • • • •  | М   | =        | 23.60 t.m  |
|  |  |     |          |  |
| Toc  |  |     |          |  |
| Shearing force   |  |     |          |  |
| 00   |  |     |          |  |
|  | Qr = (26.50 + 23.86)/2 x 1.0   |     | =        | 25.18 t  |
|  | $Qr = (26.50 + 23.86)/2 \times 1.0$<br>$Qc = -1.0 \times 1.0 \times 2.4$   |     | 11       | 25.18 t<br>-2.40 t                                     |
| - reaction   |  |     |          |  |
| <ul><li>reaction</li><li>concrete</li></ul>  | $Qc = -1.0 \times 1.0 \times 2.4$  | Q   | Ħ        | -2.40 t  |
| <ul><li>reaction</li><li>concrete</li><li>uplift</li></ul>   | $Qc = -1.0 \times 1.0 \times 2.4$  | Q   | =        | -2.40 t<br>0.15 t                                      |
| <ul> <li>reaction</li> <li>concrete</li> <li>uplift</li> <li>Bending moment</li> </ul>                                     | Qc = -1.0 x 1.0 x 2.4<br>Qu = 0.29 x 1.0/2   | Q   | =        | -2.40 t<br>0.15 t                                      |
| <ul> <li>reaction</li> <li>concrete</li> <li>uplift</li> <li>Bending moment</li> </ul>                                     | Qc = -1.0 x 1.0 x 2.4<br>Qu = 0.29 x 1.0/2<br>Mr = 23.86 x 1.0 x 1.0/2   | Q   |          | -2.40 t<br>0.15 t<br>22.93 t                           |
| <ul><li>reaction</li><li>concrete</li><li>uplift</li></ul>   | Qc = -1.0 x 1.0 x 2.4<br>Qu = 0.29 x 1.0/2<br>Mr = 23.86 x 1.0 x 1.0/2<br>+ 2.64 x 1.0/2 x 1.0 x 2/3   | Q   | =        | -2.40 t<br>0.15 t<br>22.93 t<br>12.81 t.m              |
| <ul> <li>reaction</li> <li>concrete</li> <li>uplift</li> <li>Bending moment</li> <li>reaction</li> <li>concrete</li> </ul> | Qc = $-1.0 \times 1.0 \times 2.4$<br>Qu = $0.29 \times 1.0/2$<br>Mr = $23.86 \times 1.0 \times 1.0/2$<br>+ $2.64 \times 1.0/2 \times 1.0 \times 2/3$<br>Mc = $-2.4 \times 0.5$ | Q   |          | -2.40 t<br>0.15 t<br>22.93 t<br>12.81 t.m<br>-1.20 t.m |
| <ul> <li>reaction</li> <li>concrete</li> <li>uplift</li> <li>Bending moment</li> <li>reaction</li> </ul>                   | Qc = -1.0 x 1.0 x 2.4<br>Qu = 0.29 x 1.0/2<br>Mr = 23.86 x 1.0 x 1.0/2<br>+ 2.64 x 1.0/2 x 1.0 x 2/3   | Q   |          | -2.40 t<br>0.15 t<br>22.93 t<br>12.81 t.m              |

# (3) Case III

2)

1) EL. 121.000 m

| - earth | $Qc = 0.241 \text{ x} (1.93 - 1.00) \text{ x} 4.0^2/2$ | =  | 1.79 t   |
|---------|--|----|----------|
| - water | $Qw = 11.0^2/2$  | =  | -60.50 t |
|         | $Qw = 8.0^2/2$   | =  | 32.00 t  |
|         | 0  | == | -26.71 t |

# Bending moment

| - earth | Mc = 1.79 x 4.0/3    |   | Ξ | 2.39 t.m    |
|---------|----------------------|---|---|-------------|
| - water | Mw = -60.50 x 11.0/3 |   | = | -221.83 t.m |
|         | Mw = 32.00 x 8.0/3   |   | = | 85.33 t.m   |
|         | •<br>•               | М | = | -134.11 t.m |

2)

# Toe

| Shearing force |                                    |   |      |          |  |
|----------------|------------------------------------|---|------|----------|--|
| - reaction     | $Qr = 0.04 \times 0.15/2$          |   | =    | 0.01 t   |  |
| - concrete     | $Qc = -1.0 \times 1.0 \times 2.40$ |   | =    | -2.40 t  |  |
| - water        | $Qw = -13.0 \times 1.0 \times 1.0$ |   | =    | -13.00 t |  |
| - uplift       | Qu = (14.00 + 13.57)/2 x 1.0       |   | =    | 13.79 t  |  |
|                |                                    | Q | - == | -1.60 t  |  |
|                |                                    |   |      |          |  |

# Bending moment

| - reaction | $Mr = 0.01 \times 0.15/3$        | . =  | 0.01 t.m  |
|------------|----------------------------------|------|-----------|
| - concrete | $Mc = -2.4 \times 1.0/2$         | =    | -1.20 t.m |
| - water    | Mw = -13.0 x 1.0/2               | =    | -6.50 t.m |
| - uplift   | $Mu = 13.57 \times 1.0/2 + 0.43$ |      |           |
|            | x 1.0/2 x 1.0 x 2/3              | =    | 6.93 t.m  |
|            | Ν                                | /I = | -0.76 t.m |