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A. zero was kept again by an open draining.

Search after the settlement of the soil surface surrounding the foundation pit. During the digging of the foundation pit some fixed height-points (see Appendix 1, points numbered 1 till 10), required by the construction, were brought on the surrounding field. By a levelling the height of these points, in regard with distant points of which the height was exactly known, was fixed and regularly inspected. It was stated that, the draining of the foundation, set going, the fixed height-points permanently came to lower level.

On Appendix 3 is a graphic representation of the settlements of these points 1 till 10. It can be seen that:

1. All settlements had about the same course;
2. During the period of the open draining and the first months of the well-point system the increase of the settlement was greater than that during the period in which a constant gauge was upheld by the well-point system;
3. After finishing the well-point system no settlement of the soil surface took place.

As the settlement of the soil surface could be explained only in connection with the changes of the groundwaterlevel, in consequence of the draining of the foundation pit it was desirable to know the rising of the groundwater below the soil surface. To know this, a gauge tube, that reached with its lower side below the layer of peat, was placed at every point of which the height was regularly controlled and in which the rising of the groundwater was measured.

On the Appendix 3, 4, 5 and 6 are marked the settlements of the soil surface and the corresponding groundwaterlevel for the observation points 1, 2, 4 and 5. From this information it is apparent that in the points referred to, the level of the groundwater was lower than the lower side of the clay and peat complex.

As it is also of importance to know the expanse of the settling ground several fixed points were placed till a maximum distance of 1500 m from the foundation pit. The height of these points was regularly controlled. At some of these points a gauge tube was placed to measure the groundwaterlevel. From the gathered information could be deduced that, in the points, of which the rising height of the groundwater was above the lower side of the peatcomplex, the soil surface had settled too (see Appendix 7).

By means of the measured settlements of the soil surface the limitations of the ground could be fixed. On Appendix 1 this limitation and also the one of the ground in which the settlement of the soil surface was more than 15 cm is marked.

Conclusion. Cause of the settlements must be sought in the consolidation of the layers of peat, resultant on the reducing of the groundwaterpressure. The extent of the settlement is chiefly dependent on the extent of the pressure reduction and on the compressibility of the various layers. At greater distances the settlement was less than that at the shortest distance of the foundation pit.

The slump of the soil surface settled up to a distance of about 1000 m from the pit at the north side. That the slump settled up less in the direction of the river Lek, finds its explanation in the circumstance that the thickness of the layer of peat decreases and on some places the layer of peat is missing entirely.

The nearness of the river, too, will have exerted influence on the rising of the groundwater.

No. F-11

**THE NATIONAL THEATRE BUILDING AND EFFORTS MADE TO PREVENT ITS FURTHER SINKING**

**José G. Ledesma, Commis. Engineer, Mexico City**

The National Theatre building is located on the Eastern end of the Alameda Park with nearest constructions on its Eastern side and the furthest towards the West. The lot on which it stands was the site of the Santa Isabel Church and Convent, both of considerably more weight on the Eastern and Southern faoades than the Theatre structure.

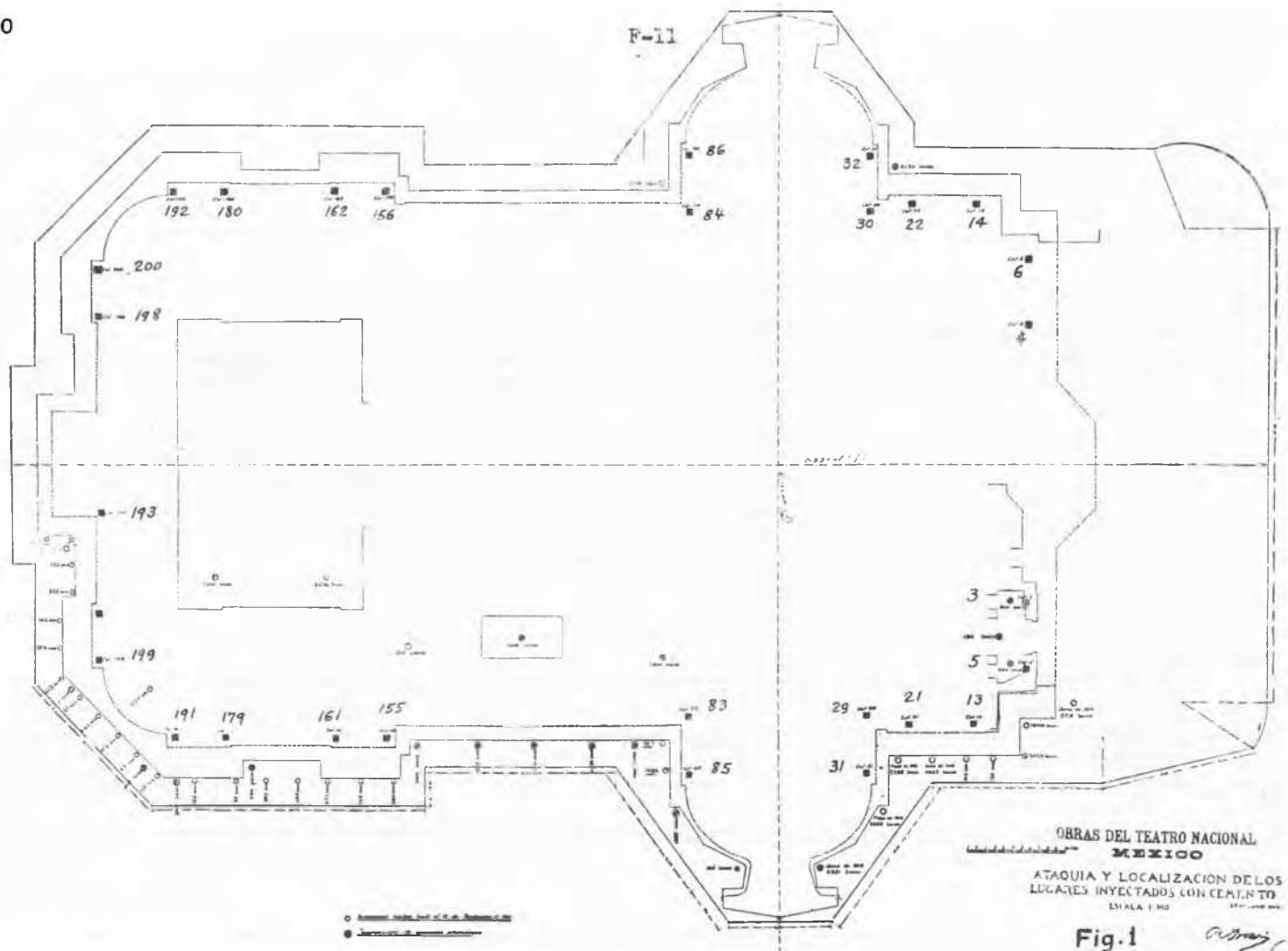
The structure has a steel frame planned by Mr. William H. Birkmire, an engineer from New York City, according to instructions and data sumministered by the architect in charge, an Italian, Adamo Boari. The firm Milliken Bros. of New York were contractors for the frame, part of which they built in New York and the rest in Germany.

The outside walls are concrete, 17.32 inches thick, and fill the spaces between beams and columns of each story.

The faoades are thick marble anchored with metal hooks to the structures and resting on the grillage of the foundation. All marblostone used is from the native quarries of Mexico as follows: the base, red sepia marble from Tenayo, Yautepec, State of Morelos; the wall facings are in white marblostone from Buenavista, State of Guerrero; mouldings and ornaments in white crystal and clouded marble from Tatatila, State of Veracruz, and the statuary marble from Carrara, Italy.

Inside walls are, some in concrete 17.32 in. thick, and others in "Roembling" brick, 2 and 5 inches, the former resting on beams and the bricks bonded to the structure. One cannot help but notice the extreme heaviness of the concrete walls and vaults, so unnecessary in the case of a steel frame building; they could have been greatly reduced without affecting the architectural plans in any way and yet, economizing in weight and cost.

Steel frame runs throughout the balcony, boxes, gallery and the stairways that give access to them,



OBRAS DEL TEATRO NACIONAL  
MEXICO  
ATAQUA Y LOCALIZACION DE LOS  
LUGARES INYECTADOS CON CEMENTO  
Escala 1:50

Fig.1

dressed with "Roembling" brick and decorative plastering.

The flooring consists of heavy girders locked to the main beams and sectioned. They have a load capacity of 2200 lbs per 1.20 square yard.

**Foundations.** The foundations of the structure was planned by engineer Birkmire and consists of a metal grillage set in a double course of trussed girders. Those which form the base for the columns and main walls have a 24 inch height at the arch and their weight varies, according to the load, from 80 to 100 lbs per foot; those that distribute the load over the foundation bed are 15 inches, and their weight from 42 to 60 lbs per foot. All axes are trussed and the receiving girders loaded at the ends. The disposition of the girders in all round towers is radial. The grillage rests on individual concrete beds 52 in thick and the whole solidified in concrete. There are 210 columns symmetrically distributed over the longitudinal axis of the structure (North by South), with both loads balanced.

#### Loads.

|  | DATA       |               |
|--|------------|---------------|
| Surface of the Concrete Platform                         | 7,450      | square meters |
| Surface of the Steel Grillage                            | 4,249      | " "           |
| Concrete volume  | 17,941     | ubic meters   |
| Concrete weight, 2300 kilograms<br>per cubic meter ----- | 41,264,300 | kilograms     |
| Weight of Steel grillage                                 | 1,667,210  | "             |
|  | -----      |               |
| Total weight of Platform                                 | 42,931,510 | kilograms     |
| Column loads   | 44,523,000 | "             |
| Total weight ---   | 87,454,510 | "             |

Since the concrete platform distributes the loads to the area of the soil, the load per unit would be 87,454,510 kilograms divided by 7,540 meters sq., or 11,739 kilograms per square meter, that is, 1.174 kilograms per sq. centimeter.

**Sinking Motion.** After the platform was finished, it started a uniform sinking motion reaching after the first six months a level 0.073 meter below. Afterwards, it sank lower at the gravity center, leaving a slightly concave part on the surface. In order to level all steel structural columns their foundations

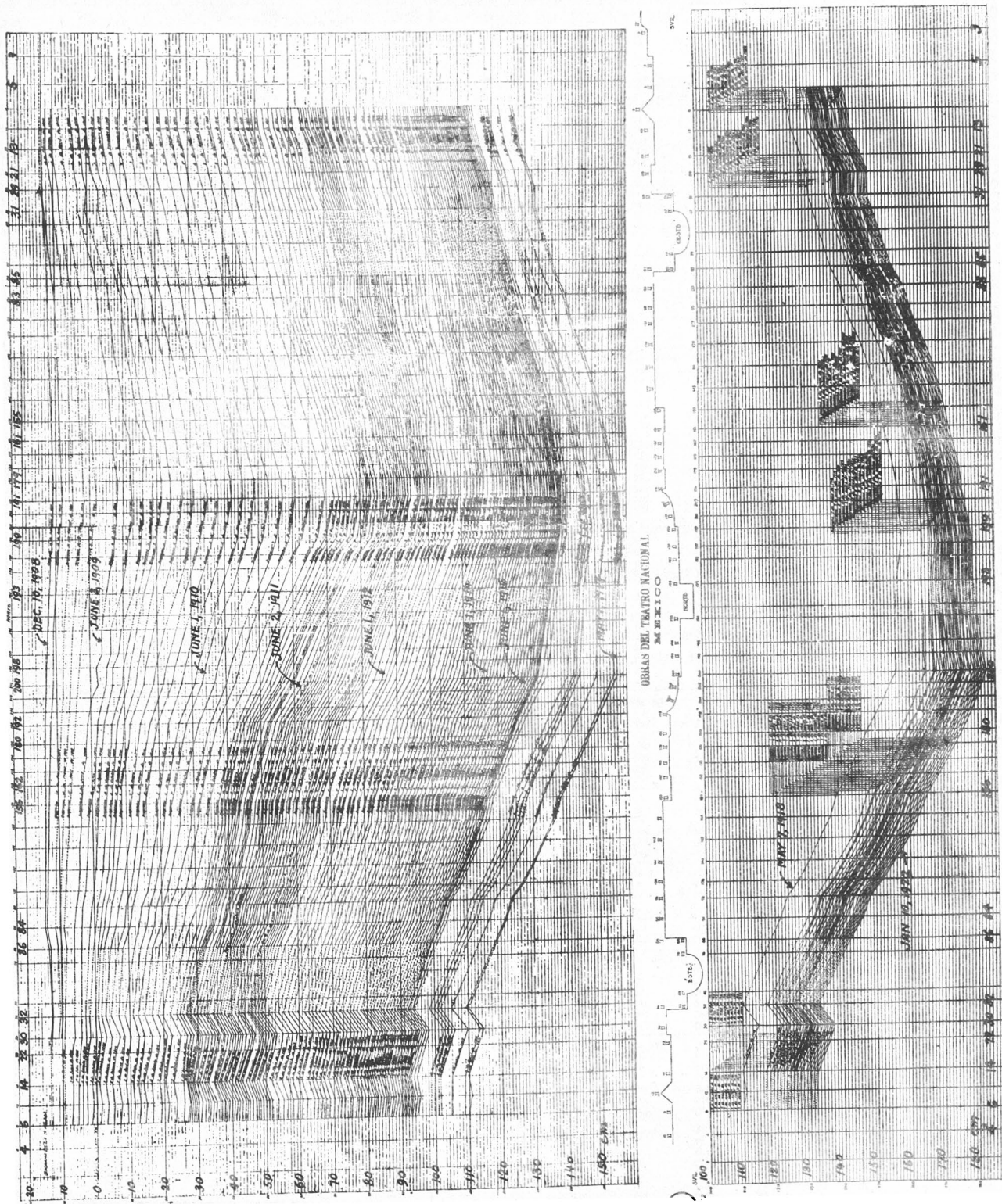


FIG.2 SETTLEMENTS OF NATIONAL THEATRE - MEXICO CITY  
FOR LOCATION OF COLUMNS SEE FIG.1.

PROMEDIOS DE HUNDIMIENTOS MENSUALES DE LAS COLUMNAS PECULIARES DEL PERIMETRO DEL TEATRO NACIONAL Y COTAS MAXIMAS EN LOS PERIODOS DE TIEMPO INDICADOS

| LADO ORIENTE                       |          |                           | LADO PONIENTE<br>Columnas inyectadas |          |                           | EPOCAS | LADO NORTE             |          |                           | LADO SUR               |          |                           |
|------------------------------------|----------|---------------------------|--------------------------------------|----------|---------------------------|--------|------------------------|----------|---------------------------|------------------------|----------|---------------------------|
| FECHAS                             | Columnas | Hundi-<br>mientos<br>mms. | Cota<br>máxima<br>mms.               | Columnas | Hundi-<br>mientos<br>mms. |        | Cota<br>Máxima<br>mms. | Columnas | Hundi-<br>mientos<br>mms. | Cota<br>máxima<br>mms. | Columnas | Hundi-<br>mientos<br>mms. |
| Enero<br>a<br>Dic.<br>de<br>1909   | No. 14   | 11.9                      | 8                                    | No. 13   | 10.8                      | 101    | No. 199                | 39.0     | 260                       | No. 5                  | 19.5     | 163                       |
|                                    | 32       | 12.0                      | 17                                   | 31       | 22.0                      | 135    | 193                    | 28.9     | 229                       |                        |          |                           |
|                                    | 86       | 13.6                      | 28                                   | 85       | 24.9                      | 175    | 194                    | 26.0     | 190                       | No. 6                  | 12.0     | 12                        |
|                                    | 96       | 13.8                      | 51                                   | 95       | 26.3                      | 196    | 200                    | 24.0     | 158                       |                        |          |                           |
|                                    | 144      | 13.8                      | 87                                   | 143      | 29.0                      | 238    |                        |          |                           |                        |          |                           |
| Enero<br>a<br>Agosto<br>de<br>1910 | 156      | 13.8                      | 88                                   | 155      | 30.2                      | 250    |                        |          |                           |                        |          |                           |
|                                    | 192      | 20.8                      | 115                                  | 191      | 32.0                      | 276    |                        |          |                           |                        |          |                           |
|                                    | No. 14   | 19.4                      | 163                                  | No. 13   | 30.6                      | 346    | No. 109                | 36.8     | 554                       | No. 5                  | 28.0     | 327                       |
|                                    | 32       | 18.5                      | 165                                  | 31       | 31.4                      | 387    | 193                    | 33.4     | 496                       |                        |          |                           |
|                                    | 86       | 20.6                      | 192                                  | 85       | 31.3                      | 425    | 194                    | 32.8     | 452                       | No. 6                  | 19.3     | 166                       |
| Sept.<br>a<br>Dic.<br>de<br>1910   | 96       | 21.6                      | 224                                  | 95       | 31.5                      | 448    | 200                    | 30.5     | 402                       |                        |          |                           |
|                                    | 144      | 23.5                      | 290                                  | 143      | 29.4                      | 503    |                        |          |                           |                        |          |                           |
|                                    | 156      | 26.3                      | 298                                  | 155      | 34.1                      | 523    | No. 109                | 35.2     | 730                       | No. 5                  | 30.0     | 478                       |
|                                    | 192      | 29.6                      | 353                                  | 191      | 37.0                      | 572    | 193                    | 30.8     | 650                       |                        |          |                           |
|                                    | 86       | 23.2                      | 308                                  | 85       | 33.8                      | 593    | 194                    | 28.6     | 595                       | No. 6                  | 21.4     | 273                       |
| Enero<br>a<br>Agosto<br>de<br>1911 | 96       | 22.8                      | 338                                  | 95       | 32.4                      | 610    | 200                    | 25.6     | 505                       |                        |          |                           |
|                                    | 144      | 22.4                      | 402                                  | 143      | 35.6                      | 681    | No. 199                | 19.1     | 883                       | No. 5                  | 23.4     | 665                       |
|                                    | 156      | 21.6                      | 406                                  | 155      | 35.6                      | 700    | 193                    | 19.3     | 804                       |                        |          |                           |
|                                    | 192      | 28.8                      | 466                                  | 191      | 35.4                      | 749    | 194                    | 19.6     | 752                       | No. 6                  | 20.9     | 440                       |
|                                    | 86       | 14.1                      | 383                                  | No. 13   | 24.6                      | 699    | 200                    | 19.5     | 686                       |                        |          |                           |
| Sept.<br>a<br>Dic.<br>de<br>1911   | 32       | 16.8                      | 390                                  | 31       | 25.3                      | 745    |                        |          |                           |                        |          |                           |
|                                    | 86       | 13.8                      | 430                                  | 85       | 24.4                      | 788    | No. 199                | 15.3     | 945                       | No. 5                  | 16       | 729                       |
|                                    | 96       | 17.0                      | 474                                  | 95       | 23.8                      | 809    | 193                    | 17.3     | 873                       |                        |          |                           |
|                                    | 144      | 17.5                      | 542                                  | 143      | 22.3                      | 853    | 194                    | 18.8     | 827                       | " 6                    | 17.3     | 473                       |
|                                    | 156      | 17.6                      | 547                                  | 155      | 22.0                      | 876    | 200                    | 21.0     | 770                       |                        |          |                           |
| 1912                               | 192      | 18.8                      | 616                                  | 191      | 19.9                      | 908    |                        |          |                           |                        |          |                           |
|                                    | No. 14   | 15.5                      | 637                                  | No. 13   | 15.9                      | 947    | No. 199                | 13.5     | 1107                      | No. 5                  | 15.8     | 918                       |
|                                    | 32       | 14.4                      | 626                                  | 31       | 15.5                      | 988    | 193                    | 14.3     | 1045                      |                        |          |                           |
|                                    | 86       | 15.5                      | 685                                  | 85       | 14.8                      | 1028   | 194                    | 15.0     | 1008                      | " 6                    | 14.0     | 652                       |
|                                    | 96       | 13.2                      | 725                                  | 95       | 15.5                      | 1032   | 200                    | 15.5     | 957                       |                        |          |                           |
| 1913                               | 144      | 16.0                      | 810                                  | 143      | 14.5                      | 1096   | No. 199                | 10.4     | 1233                      | No. 5                  | 7.0      | 1009                      |
|                                    | 156      | 16.2                      | 859                                  | 155      | 14.2                      | 1112   | 193                    | 10.8     | 1175                      |                        |          |                           |
|                                    | 192      | 16.5                      | 891                                  | 191      | 13.3                      | 1130   | 194                    | 11.4     | 1144                      | " 6                    | 10.6     | 777                       |
|                                    | No. 14   | 10.9                      | 766                                  | No. 13   | 7.5                       | 1037   | 200                    | 12.3     | 1103                      |                        |          |                           |
|                                    | 32       | 10.8                      | 757                                  | 31       | 7.9                       | 1083   |                        |          |                           |                        |          |                           |
| 1914                               | 86       | 11.3                      | 818                                  | 85       | 8.7                       | 1130   | No. 199                | 8.6      | 1336                      | No. 5                  | 5.8      | 1078                      |
|                                    | 96       | 11.3                      | 860                                  | 95       | 8.0                       | 1153   | 193                    | 9.8      | 1294                      |                        |          |                           |
|                                    | 144      | 11.8                      | 951                                  | 143      | 9.8                       | 1213   | 194                    | 10.5     | 1270                      | " 6                    | 7.6      | 866                       |
|                                    | 156      | 11.7                      | 960                                  | 155      | 9.8                       | 1230   | 200                    | 11.3     | 1240                      |                        |          |                           |
|                                    | 192      | 12.6                      | 1043                                 | 191      | 10.2                      | 1252   |                        |          |                           |                        |          |                           |
| 1915                               | No. 14   | 8.2                       | 864                                  | No. 13   | 5.9                       | 1107   | No. 199                | 6.7      | 1415                      | No. 5                  | 5.2      | 1140                      |
|                                    | 32       | 8.3                       | 855                                  | 31       | 5.9                       | 1154   | 193                    | 7.6      | 1385                      |                        |          |                           |
|                                    | 86       | 9.3                       | 929                                  | 85       | 6.3                       | 1207   | 194                    | 8.3      | 1368                      | " 6                    | 6.7      | 945                       |
|                                    | 96       | 9.7                       | 977                                  | 95       | 6.7                       | 1235   | 200                    | 8.8      | 1345                      |                        |          |                           |
|                                    | 144      | 10.3                      | 1075                                 | 143      | 7.2                       | 1299   |                        |          |                           |                        |          |                           |
| 1916                               | 156      | 10.6                      | 1086                                 | 155      | 7.1                       | 1317   | No. 199                | 6.3      | 1491                      | No. 5                  | 4.0      | 1187                      |
|                                    | 192      | 11.7                      | 1182                                 | 191      | 7.5                       | 1347   | 193                    | 6.5      | 1462                      |                        |          |                           |
|                                    | No. 14   | 6.0                       | 945                                  | No. 13   | 5.0                       | 1185   | 194                    | 7.3      | 1457                      | " 6                    | 5.0      | 1016                      |
|                                    | 32       | 7.0                       | 940                                  | 31       | 4.8                       | 1210   | 200                    | 8.3      | 1447                      |                        |          |                           |
|                                    | 86       | 6.8                       | 1019                                 | 85       | 4.8                       | 1245   |                        |          |                           |                        |          |                           |
| 1917                               | 96       | 6.4                       | 1033                                 | 95       | 5.7                       | 1302   | No. 199                | 5.8      | 1560                      | No. 5                  | 4.6      | 1241                      |
|                                    | 144      | 7.7                       | 1166                                 | 143      | 6.3                       | 1375   | 193                    | 6.5      | 1541                      |                        |          |                           |
|                                    | 156      | 7.8                       | 1180                                 | 155      | 6.3                       | 1390   | 194                    | 6.6      | 1536                      | " 6                    | 4.8      | 1074                      |
|                                    | 192      | 8.5                       | 1284                                 | 191      | 7.5                       | 1415   | 200                    | 7.1      | 1532                      |                        |          |                           |
|                                    | No. 14   | 5.8                       | 1015                                 | No. 13   | 3.9                       | 1213   |                        |          |                           |                        |          |                           |
| 1918                               | 32       | 6.5                       | 1018                                 | 31       | 4.0                       | 1258   | No. 199                | 5.1      | 1621                      | No. 5                  | 4.3      | 1291                      |
|                                    | 86       | 7.5                       | 1100                                 | 85       | 4.7                       | 1320   | 193                    | 5.9      | 1612                      |                        |          |                           |
|                                    | 96       | 7.9                       | 1148                                 | 95       | 4.3                       | 1354   | 194                    | 6.2      | 1610                      | " 6                    | 5.3      | 1137                      |
|                                    | 144      | 8.5                       | 1270                                 | 143      | 4.8                       | 1433   | 200                    | 7.0      | 1616                      |                        |          |                           |
|                                    | 156      | 8.5                       | 1282                                 | 155      | 4.8                       | 1446   |                        |          |                           |                        |          |                           |
| 1919                               | 192      | 9.1                       | 1306                                 | 191      | 6.2                       | 1490   | No. 199                | 5.5      | 1677                      | No. 5                  | 3.5      | 1333                      |
|                                    | No. 14   | 5.1                       | 1076                                 | No. 13   | 4.1                       | 1260   | 193                    | 5.1      | 1673                      |                        |          |                           |
|                                    | 32       | 5.1                       | 1079                                 | 31       | —                         | 1372   | 194                    | 5.6      | 1677                      | " 6                    | 3.0      | 1184                      |
|                                    | 86       | 5.5                       | 1106                                 | 85       | 4.3                       | 1372   | 200                    | 6.0      | 1689                      |                        |          |                           |
|                                    | 96       | 5.6                       | 1215                                 | 95       | 4.8                       | 1411   |                        |          |                           |                        |          |                           |
| 1920                               | 144      | 5.5                       | 1336                                 | 143      | 4.7                       | 1489   | No. 199                | 3.0      | 1724                      | No. 5                  | 3.5      | 1373                      |
|                                    | 156      | 6.5                       | 1380                                 | 155      | 5.0                       | 1506   | 193                    | 4.5      | 1728                      |                        |          |                           |
|                                    | 192      | 6.6                       | 1472                                 | 191      | 4.9                       | 1549   | 194                    | 5.0      | 1738                      | " 6                    | 4.8      | 1242                      |
|                                    | No. 14   | 4.3                       | 1191                                 | No. 13   | 3.4                       | 1355   | 200                    | 3.5      | 1755                      |                        |          |                           |
|                                    | 32       | 4.4                       | 1199                                 | 31       | 3.4                       | 1401   |                        |          |                           |                        |          |                           |
| 1921                               | 86       | 4.9                       | 1298                                 | 85       | 3.6                       | 1466   | No. 199                | 4.7      | 1781                      | No. 5                  | 4.8      | 1433                      |
|                                    | 96       | 4.7                       | 1346                                 | 95       | 3.8                       | 1510   | 193                    | 5.2      | 1790                      |                        |          |                           |
|                                    | 144      | 5.5                       | 1486                                 | 143      | 4.1                       | 1596   | 194                    | 5.3      | 1802                      | " 6                    | 5.8      | 1312                      |
|                                    | 156      | 5.8                       | 1509                                 | 155      | 4.1                       | 1610   | 200                    | 6.0      | 1827                      |                        |          |                           |
|                                    | 192      | 6.3                       | 1638                                 | 191      | 4.2                       | 1659   |                        |          |                           |                        |          |                           |
| 1922                               | No. 14   | 5.1                       | 1252                                 | No. 13   | 3.4                       | 1306   | No. 199                | 4.7      | 1781                      | No. 5                  | 4.8      | 1433                      |
|                                    | 32       | 5.1                       | 1260                                 | 31       | 3.4                       | 1442   | 193                    | 5.2      | 1790                      |                        |          |                           |
|                                    | 86       | 4.9                       | 1357                                 | 85       | 3.4                       | 1507   | 194                    | 5.3      | 1802                      | " 6                    | 5.8      | 1312                      |
|                                    | 96       | 5.5                       | 1412                                 | 95       | 3.5                       | 1533   | 200                    | 6.0      | 1827                      |                        |          |                           |
|                                    | 144      | 5.5                       | 1552                                 | 143      | 3.6                       | 1640   |                        |          |                           |                        |          |                           |
| 1923                               | 156      | 5.8                       | 1577                                 | 155      | 3.7                       | 1655   | No. 199                | 4.7      | 1781                      | No. 5                  | 4.8      | 1433                      |
|                                    | 192      | 5.8                       | 1706                                 | 191      | 3.5                       | 1702   | 193                    | 5.2      | 1790                      |                        |          |                           |
|                                    | No. 14   | 5.8                       | 1322                                 | No. 13   | 4.8                       | 1454   | 194                    | 5.3      | 1802                      | " 6                    | 5.8      | 1312                      |
|                                    | 32       | 5.5                       | 1326                                 | 31       | 4.7                       | 1490   | 200                    | 6.0      | 1827                      |                        |          |                           |
|                                    | 86       | 5.5                       | 1423                                 | 85       | 4.9                       | 1566   |                        |          |                           |                        |          |                           |

El cero está referido al disco superior del Pozo Artesiano.  
Véanse Gráficas.—Plano No. 483.

were wedged with steel plate.

The sinking motion continued uniformly until 1907; however, when the structural steel frame was completed and the walls started going up, the platform sank lower on the southwest side: after a few months the inclination changed towards the Northeast; hence, the movements were faster on the Western facade (on the Park side) than on the Oriental side (towards the Post Office building), both faoades showing a sinking motion from South to North (stronger on the Western side). Also, the Northern faoade was sinking more rapidly than the Southern faoade and both showed inclination towards the West so that the lowest corner was the Northwest.

An investigation was started to find out the reason for this behavior of the subsoil; it was figured that, on the Eastern side (towards the Post Office), the subsoil would be of a more compact nature on account of the weight of the old constructions of the church and convent of Santa Isabel, but that the weight of the new Buildings of the Post Office and the Mutual would influence the sinking motion towards that side.

Several pits were dug around the platform in order to study the behaviour of the under currents of water and the fluctuations in their level and it was found that there was a stream of water running in a Northeast direction which seemed to be the connection with the sinking axis of the platform.

Sinking Causes. The sinking below surface of the entire building is due to the mistake of having allowed a greater load than the subsoil of the City of Mexico can stand; moreover, after having excavated down to 2.50 and 3.50 meters to form the bed for the concrete platform, at a level where the subsoil is quite insecure. The concrete load of the platform weighs 41,264,300 kilograms and the metal grill for the foundations 1,677,210 kilograms. So that, minus a small difference, the concrete in the platform weighs as much as the upper structure and by itself, only a load of 544 grams per square centimeter, which represents a fair load for this type ground.

The deformity noted towards the center of the platform was due to the concentration of pressures towards the central point and its disadvantage counteracted by the placing of wedges beneath the bases of the columns as stated before.

Means Employed to Check the Sinking Cofferdam. To counteract the effect of the undercurrents of water, it was decided to build a cofferdam, and engineer John N. O'Rourke from New York was called upon, as his reputation in this line was very high. The plans submitted by Mr. O'Rourke included a cofferdam constructed with material known in the United States as interlocking corrugated steel sheet piling, to surround the platform at a distance of three meters. The sheet iron forming the cofferdam would be 25 feet long and were to be bonded to the platform by means of caissons of concrete.

In order to better point out the advantages in general of cofferdamming and in this particular case, to the suggestion made by Mr. O'Rourke, we must make a brief analysis of the reasons for the sinking of Mexico's buildings.

The subsoil of the City of Mexico is seepage ground with 50 to 80% water and formed of argillaceous materials, volcanic ash and fine sand; this makes an unstable and cohesionless subsoil.

The water element is subject to daily short fluctuations specially noticeable during the rainy spells and in dry seasons. These fluctuations are the main cause for the settling of buildings.

During the rainy season the water reaches its highest level and occupies all the space between the olayish formation; in winter the water level drops to its lowest expression. This drifting carries with it the finer particles also, and when the water leaves, the subsoil offers less resistance to the pressure of the structures and these naturally begin to settle down.

Due to the continuous sinking motion of the structure of the National Theatre, work on the buildings was abandoned for several years until 1923 when, at the suggestion of engineer Vicente Cortes Herrera, then Director of Buildings and Monuments, the subsoil was injected with a mixture of clay, lime and sand which stopped the settling of the building to the extent that it was possible to complete the structure in 1934. Since then, there have been a few settling motions but altogether the work was successful.

The injection of the mixture was carried out under the supervision of engineers Barocio and Alvarez Varela.