

In 1772 the formation at Gibraltar of the "Company of Soldier Artificers," officered by Royal Engineers, was authorized, and in 1787 the "Corps of Royal Military Artificers" was established at home. In 1813 its title was changed to the "Royal Sappers and Miners," doubtless on account of the intrenching and subterranean nature of much of its work. In 1856, after the Crimean War, it was incorporated with the "Corps of Royal Engineers," by whom it had always been officered. There is a School of Military Engineering at Chatham, England, (the headquarters of the corps) where officers are trained, and where the official textbooks on military engineering are compiled.

The ordinary strength of the regular Royal Engineers of the British Army is about 10,000 officers and men, with mounted and dismounted sections. The territorial and overseas forces also include a proportional complement of Engineers. The privates (called "sappers") in the regular Royal Engineers are generally skilled artisans. They are trained in tactics and the use of the rifle and are paid at a higher rate than infantrymen. The utility of this important branch of the service has frequently been shown in the course of the present war, especially on demolitions, entanglements and bridges.

### DRAINAGE STRUCTURES.\*

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**I**N determining the length of bridges and spans between bents and piers and the size of culverts, consideration is given to the maximum rainfall, amount of run-off, average slope of ground of drainage area, seepage, etc., as included in the same factors governing similar structures under railroad construction. After determining the required opening for waterway, the factor governing the required strength or carrying power of the structure is determined, so far as it is possible, upon the maximum load the structure is likely to be subjected during its bonded life. As to the bonded life of structures of this character, it is figured that they should last until bonds or taxes voted for the construction of same are retired, all structures being computed, however, to safely carry a minimum live load of not less than ten tons, plus 50 per cent. impact and a factor of safety of four.

**Standard Plans.**—It has been the policy of the highway commission of Louisiana to construct, wherever funds and conditions will permit, permanent structures and adopt uniform and standard plans for bridges and culverts for any particular highway project. However, oftentimes different designs are necessary to meet existing conditions. The type and design of bridges, whether they be of wood, concrete, or masonry, etc., are determined largely by the amount of funds available, and the character and nature of soil for foundation.

Due to the alluvial character of the soil, with the exception of some sections in the northern part of the State, there are instances where it is not safe nor economical to construct the arch type of concrete bridges; even with some of our girder and slab bridges, it oftentimes becomes necessary to provide pile foundations for the piers, abutments and wing walls. In some places it is necessary for these piles to be of concrete instead of wood on account of many reclamation projects, now under way, lowering the ground water which would become detrimental to the latter type of construction.

\*From a paper read at the Fourth American Road Congress, Atlanta, Ga., Nov. 9 to 14, 1914.

**Uniform Design.**—We have found it advantageous and economical to provide, where conditions will permit, a uniform design for all drainage structures, especially for those of concrete construction, that the contractor may use the same drainage forms over and over, permitting thereby much lower bids per cubic yard on such work than otherwise under a system of non-uniform standard designs for such structures, and in addition, many times permitting, without greater cost, greater waterway opening than theoretically computed, resulting in a larger factor of safety, and often providing for some unprecedented rainfall or cloudburst not anticipated. In addition to concrete bridges, the department is building many wooden bridges, both of creosoted and uncreosoted materials; this character of construction predominating in some parishes due to lack of funds for more permanent construction.

**Types of Culverts.**—The department has installed several types of culverts, that of vitrified clay, cement, concrete, cast iron, wood, corrugated galvanized iron, etc., the type of construction being governed by the available funds and topographical features together with character of soil encountered in foundation. However, where practicable, concrete has always been recommended.

At many places, however, we have found it impracticable and not economical to use concrete culverts and others of a monolithic character, especially in some of the bayous and coulees. In one place in particular, it is recalled, where the foundation in one bayou was so poor that a strip 2 in. x 2 in. x 16 ft. was pushed down its full length in the bottom of the bayou, and could have been pushed farther if the strip had been longer. This bayou was 250 ft. wide across the top and 25 ft. deep, and the only opening necessary was that of an equalizer with an area of some 28 sq. ft. to be filled over with earth, thereby making a bridge of earth and of an equalizer. The equalizer installed at this particular location was a 10-gauge 6-ft. diam. corrugated galvanized iron pipe culvert. The entire cost of this combination bridge, if it may be so termed, amounted to \$2,059.27, including an item of \$215.73 for riprap, whereas to have bridged the bayou with concrete, or to have attempted to build a concrete culvert, would have made the cost very much in excess of this amount.

Due to debris, drift wood, and other extraneous matter, our highway department has adopted a policy not to install any culverts of less than 18 in. in diam. where possible, it preferring that they should be not less than 24 in. in diam. Experience has shown that culverts of these sizes have proven more satisfactory and given better service, requiring less maintenance both for road and culvert at such places than when culverts of smaller diameter are used, even though the smaller culverts are ample to carry the water, due to the ineffectiveness of the latter from drift choking and filling them up.

### PACIFIC GREAT EASTERN RAILWAY CONSTRUCTION.

The British Columbia Government has decided to guarantee bonds to enable the Pacific Great Eastern Railway Company to float a loan of \$5,000,000, to provide for further construction.

The American Society for Testing Material has added to its specifications for reinforcing steel rolled from billets, an intermediate grade between the structural and hard grades. The new grade has a yield-point of 40,000 lbs., and an ultimate tensile strength of from 70,000 to 85,000 lbs.