PREFACE

The *structures* are solid bodies to which we ask to bear in safety the mechanical and/or thermal applied load. At times, we also wonder to them to contain some displacements within limits fixed in advance. When the load applied on the structure doesn't vary in the time, we say that it deals with a problem of *Statics*. If the load is varying in the time, we say that it deals with a problem of *Dynamics*.

This book furnishes the fundamental notions of the *Statics*. It constantly deals with the matters in exhaustive but clear way, within the classical *Physics* and the classical *Mathematical analysis*. It mainly wants to make available to the *Engineer* all the necessary operational tools to correctly formulate and to resolve whatever problem of *Statics*, related to structures of elevated complexity also.

The study of the *Statics* begins with the exposure of the *Theory of vectors* (chap. 1). It deals with a matter of the *Mathematical physics*, completed with a technique of graphic calculation called *funicular polygon*.

The structures are formed by one-dimensional beams connected among them and the foundation from bilateral constraints (whose physical description and analytical simulation are given in chap. 2). The basic element of any one-dimensional structure is the *thermoelastic deflected beam*. Its mathematical model is detailed in chap. 2. The linearity of such model implies two mathematical properties, called *superposition principle* and *displacements principle*. Their proof is elementary, but they are revealed to be of *fundamental operating importance* for the execution of the calculations of the *Statics*.

The structural analysis begins with the *Kinematics* (chap. 3). The *kinematic matrix* of the structure is built. It allows to establish if

- the constraints are insufficient. In such case the structure is kinematic. It is called *labile* and the number of its release degrees is denoted with ***r***
- the constraints are strictly sufficient. In such case we say that the structure has *hyperstatic degree* ***h***=0. Any structure having ***r***=0 and ***h***=0 is called *isostatic*
- the constraints are superabundant. The sum of the orders of the

superabundant constraints is denoted with ***h***. Any structure having ***r***=0 and ***h***>0 is called *hyperstatic*.

The *kinematic analysis* is completed by an operating technique called *kinematic chains*.

After that, the *Statics* begins with the building of the *static matrix*, immediately followed by the *kinematic-static duality* (chap. 4). The *duality* assures that

- in any *labile* structure the constraints cannot balance any load and then it is able to collapse. But if none of the release degree is excited from the load, the structure behaves like isostatic or hyperstatic
- in any *isostatic* structure the constraints balance the load in unique way
- in any *hyperstatic* structure the constraints can balance the load in infinite way. However, the last result is true only in the *Statics of rigid bodies*. In chap. 5 it is shown that in any real (and then deformable) *hyperstatic* structure the constraints balance the load in unique way.

Actually, in *Statics* the *automatic structural calculus* allows to determine the state of stress and the field of displacements of any non-labile structure. The technique employed (detailed in chap. 4) is founded on the *displacements principle* and it is called *displacements method*.

But *inevitably* any automatic structural calculation does approximations that sometimes have produced output containing dangerous errors. To avoid such errors, the *structural Engineer* must know *also* the other techniques of calculation of the *Statics*, briefly called *forces method*.

In any *isostatic* structure, to calculate the state of stress the *forces method* can employ *only* considerations of equilibrium (chap. 5). The *graphic Statics* is a useful additional tool.

In any *hyperstatic* structure, to calculate the state of stress the *forces method* must *also* employ considerations of congruence or the *virtual works principle* (chap. 6).

Roma, Italy Aldo Maceri

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