

EXTRACT FROM "LA NAZIONE" OF 10TH JUNE, 1887.

AGAINST THE DESTRUCTIVE EFFECTS OF EARTHQUAKES.

The illustrious Father Bertelli has forwarded to us the following letter, which we have much pleasure in publishing.

TO THE EDITOR OF "LA NAZIONE."

FLORENCE, COLLEGIO ALLA QUERCIA,
7th, June, 1887.

SIR,—The recent disastrous earthquakes of Liguria, have perhaps done even more than those of Ischia in stimulating Italian and foreign Seismologists to study earthquake phenomena, as well as technical men to provide, promptly and in the most efficacious way, the necessary repairs and means of protecting buildings in order to at least lessen future destruction. As in order to succeed in this purpose, it is necessary or at least very useful, to know the varying nature of seismic action in itself and in its effects either upon the soil or upon buildings, I have applied myself to the study of such questions and I still continue my researches. But especially in this branch of study an efficacious cōoperation of the kindred sciences is indispensable. I thought of taking the opportunity of the occurrence of the last festivals in Florence, to explain in private meetings, to be held among some of the learned men of Florence and other parts of Italy, who might be present at the result of such researches as have been made up to the present. Having, however, been able on this occasion to take advantage of the very useful cōoperation of several colleagues of mine, well versed in Seismology, Geology, Natural Philosophy, Mechanics, and in building, we could in a short time, and, by mutual agreement, discuss the proposed scientific practical programme. Reserving for papers of a pure scientific character the publication of the discussion on the various points of the same programme, I hope it will be agreeable to you, and not without advantage and interest to the readers of the papers, to publish the following practical observations concerning building matters:—

RECAPITULATION OF SOME OF THE PRINCIPAL PRACTICAL RULES
TO BE OBSERVED IN ORDER TO POSSIBLY LESSEN THE DE-
STRUCTIVE EFFECTS OF EARTHQUAKES IN BUILDINGS.

Although some of these rules have been previously suggested and practised, nevertheless in consideration of their importance, it has been deemed necessary to discuss them again and to re-propose the same, together with those following:—

1. We have to choose where the best area for buildings lies. Certainly rocks and the most compact ground ought to be preferred, especially avoiding ground of more recent formation, such as clay and sand, slopes, and still more to be avoided are boundaries where such soils come in contact with the above mentioned compact grounds. Indeed, in such localities the nonsynchronism of oscillation, the interference and the shocks of wave appear more noticeable, as also happens with shocks near the coast between the water and the shore.

2. That with regard to new buildings to be constructed care must be taken that the principal walls (especially external walls) might diagonally present their corners and not their faces in the direction of the seismic impulses prevailing in that region. In order to discover the kind of motion prevailing in given regions, some special researches have been expressly proposed in our meetings in Florence.

Besides in one of these meetings one of our distinguished colleagues has made the proposal (approved by all) that in places where, in consequence of the destruction occasioned by the earthquake, the dwellings had to be removed it might be suggested to the municipalities, to have the roads so traced that the houses and the blocks might by themselves present the situation mentioned in rule 2nd. It would be also necessary that the extreme corners of the blocks should be solidly protected by diagonal ties.

3. In places which are more exposed to earthquakes, as far as possible care should be taken that buildings should

not be too high or that they should not carry on their upper part considerable masses, as for instance stone cornices (even if the different pieces were connected together by bands), terraces, small terraces (terrazzini), and projections in general. That if such unfavourable circumstances could not be avoided, the "tying" method, which will be hereafter treated, should be applied, even to the chimneys on the roof.

4. In order that buildings may be solidly constructed, it is recommended that squared materials be used or at least that they may have at short distances insertions of brick and of bonders of stone (especially at the angles), and that the lime and the sand may be of good quality, and that salt water may not be used for slackening the lime. Generally, at least in those points more exposed to destruction, the use of vaults in the parts of the building which lie above the soil must be avoided.

5. For seismo-mechanical reasons, which, in a special memorandum, will be more particularly discussed and applied, inasmuch as different parts and walls of buildings, corresponding to the different projections and plankings, according to their various construction, mass, situation, etc., oscillate differently even during the same shock; and as this non-symmetry and non-synchronism of motion is one of the principal causes of the damage and consequent destruction of buildings, the following precautions to prevent the occurrence of such destruction have been deemed very useful.

6. Generally it must be tried, by means of proper tying, to compel these period pendulums of different length, mass, and period to oscillate together in a body, as if they constituted a single compound pendulum. To insure this, it is very useful to have bolted ties, iron joists, and a proper arrangement of flooring and beams of which we will give some details.

7. Among the different systems of flooring that may be used that formed by iron joists which are parallel to each other,

and between which a brick vault of a small chord is constructed, is to be preferred for our purpose. Besides this system we have that of the "mezzoni."* However, whichever system be adopted, it is necessary that these frames should be at intervals joined in couples by a bolted transverse, thus serving as a twin tie, in order to externally strengthen the two parallel walls on which the heads of the framing lie. In the storey above the beams of the planking are put in a direction at right angles to that of the preceding storey, as it ought to be done according to technical rules, the other two walls should be connected with the two first walls to which they are at right angles.

According to the ancient system of flooring with beams and joists it is necessary that the heads of the beams go through the whole thickness of the wall. In order to meet these conditions in already existing buildings, the heads of the floor beams may, according to circumstances, be supported by an iron transversal beam of some kind or other. In any case it will be better to join crosswise by means of beams, with bolts and keys, all opposite walls of buildings, and especially the principal walls, and this should be done in proportion as the building, with regard to its situation, is less resistant or more exposed to damage produced by a shock.

8. This last measure is to be adopted especially in the upper parts of buildings.† Indeed, several circumstances (which we will not analyze at present) concur in producing there more than elsewhere a greater oscillatory motion, and sometimes this is in an opposite direction between the different external walls, and besides (by effect of centrifugal force) a motion of transition in the truss and covering of the roof or in its projections, etc. As experience has shown during the last

* "Mezzoni" ("Cultelloni," in Florence), is a term applied to beams split into two pieces (of about 9×22 centimètres), which are lying parallel on their thickness at a distance of 28 to 30 centimètres apart for the support of the flooring.

† For this reason in ancient times houses were built low; in places subject to earthquakes they had not more than two stories.

earthquakes in Liguria, it is from the blow of falling and from the heavy weight of the roof materials on the flooring underneath, as well as from the floors totally or partially leaving their places of support, that total destruction even of the lower stories has happened.

It not being possible here to enumerate all the single special technical rules to be followed on this subject, I will confine myself to some general and more important notes. To begin with, it would be necessary to select, if possible, for the roof that system, which having a sufficient strength, is less heavy and better connected, and such as will serve at the same time to keep together the external walls when they oscillate in consequence of a seismic impulse. Therefore, if we had to select, the covering to be recommended is that of "pavilion" form with the greatest possible slope, with the use of the "maschi attata" covering. This covering is used instead of common tiles and flat tiles. In any case it would be necessary in order to protect people passing along the streets that the common tiles and flat tiles should be, near the gutter, well connected together by means of ties of galvanized iron wire, etc. It would be very advisable at least for the most dangerous places, to connect the points of support of the roof by means of strong bands, diagonals, and rods with a framed system (*trabeale concamerato*) either of timber or of iron, which in a certain manner represents between the last storey and the roof the so-called Beneventano or "barrack" system. Besides, the rules which has been already imposed on the inhabitants of the Riviera, it is recommended to use in every part of the buildings and especially in the upper stories, "longarine" or iron beams as architraves of doors and windows. If these openings are protected in such a manner they really offer a quick and relatively secure refuge.

9. The above mentioned precautions should be particularly applied to the proper construction and connection of the staircase, which is the most direct means of escaping, and could

also serve as an axis or point of connection to the remaining part of the building. Besides, even in case of partial destruction of the building, it would always present an easier, quicker, and less dangerous way for penetrating deeper under the ruins to the rescue of the inmates.

Leaving to technical men the special application of the above mentioned general principles, I shall confine myself to recommending that, at least in places which are more exposed to violent seismic commotions, the adoption of the following rules :—

- (1.) To avoid if possible the use of sloping vaults for support of the staircase.
- (2.) If it is possible, to use stone stairs of only one continuous block deeply cased into the wall.

The Tuscan method, according to which every stone stair is introduced with its head (during the construction of the building) through the whole thickness of the wall, which is thus pressing upon it, seems very good.

10. With regard to the form of the staircase, certainly the system (especially used in Tuscany) of a winding staircase should be, as one of our colleagues observed in the meeting, relatively the best ; but as in practice, such a form does not suit all the requirements of houses, and for several reasons is somewhat inconvenient, if we had to use one of the various systems of staircases with a double flight, it seems that that with a central partition wall which internally serves as a support to the stairs of both flights should be preferred.

In the most common staircases, the so-called *well* staircase, especially if the Tuscan system could not be applied, with framework and iron or timber ties, ought to be used instead of it.

I have the honour, etc.,

(Signed)

TIMOTEO BERTELLI,
Barnabit Priest.