A TREATISE ON EARTHQUAKE DANGERS, CAUSES AND PALLIATIVES

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A Treatise on Earthquake Dangers, Causes and Palliatives by Thos. Rowlandson

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Trieste

A TREATISE

ON

EARTHQUAKE

DANGERS,

CAUSES AND PALLIATIVES,

BY

THOS. ROWLANDSON,

FELLOW OF THE GEOLOGICAL SOCIETY, LONDON, AND LATE SECRETARY OF THE JOINT COMMITTEE ON EARTHQUAKE TOPICS;

COMPRISING

Earthquake Dynamics.
Earthquake Waves.
Sound that attends Shocks.
Lime, Mortar, etc.
Cosmogony and Seismogony.
Phenomena of the Neapolitan Earthquake of 1857.
General Observations Respecting Structural Arrangements.

"Diseased nature oftentimes breaks forth
In strange eruptions; and the teeming earth
Is with a kind of colic pinch'd and vex'd,
By the imprisoning of unruly wind
Within her womb; which, for enlargement striving
Shakes the old beldame earth, and topples down
High tow'rs and moss-grown steeples."—[HENRY IV.

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PREFACE.

" Our indiscretion sometimes serves us well
When our deep plots do fail; and that should teach us
There 's a divinity that shapes our ends,
Rough-hew them as we may."—[SHAKESPEARE.

The preface now submitted will be chiefly occupied with apologetic explanations for total omissions, and sparseness of details, which, if elaborated at greater length, were calculated to explain many of the mysterious phenomena of earthquakes. It is doubtful, however, whether sufficient interest exists amidst the California public to have made it probable that even the cost of publication would have been realized had a work of larger pretensions and more expensive charge been submitted to its notice. Even as it is, the writer does not anticipate realizing more than cost out of pocket of printing the present *brochure*, unless, as may happen, another earthquake shock sufficiently severe as to cause general alarm should occur within a brief period, and thus again attract fresh interest to the subject.

As will be seen on a perusal of the first portions of the body of the work, the illustrations are almost wholly confined to incidents related by Mr. Mallet of the Neapolitan earthquake of 1857. It may be explained that this is attributable to the following circumstances:

The last general meeting of the Joint Committee on Earthquake Topics was held on the 11th of March last. At that meeting certain reports were read, and discussions thereon took place. The chief one, however, related to one special topic, viz: the advisability of an early publication of the information obtained by the Committee, such a course being advocated by one party as due to the public and the credit of the Committee, and another who strongly contended for an indefinite delay—one of the stoutest advocates for such delay advancing the novel plea that, individually, they had not yet learned the science of seismology, and, by inference, the cognate sciences alluded to that branch of physics. A compromise was effected by the adoption of a resolution that the Chairmen of the various sub-committees should forward at a day conveniently early and generally understood, which has now passed, reports on the various branches of this subject, on the receipt of which the Chairman was to assemble, by summons, the members of the Joint Committee. For reasons not yet explained, this has not taken place, awaiting, probably, the time when these amateur architects, chemists, geologists and general scientists, shall have, to their own satisfaction, mastered *the alphabets* of the particular sciences on which they have undertaken to treat. A portion of the resolution adopted at the same time embraced the dismissal of the Secretary, on the ground of economy.* It will be seen, therefore, that any reports which may emanate

*The above was the alleged ground of dismissal. No economy, however, inured from such a step, as is well known to many members of the Committee.

from the individuals alluded to can only be taken as personal reports—not as the results of the deliberate consultation of a Committee organized for the special purpose, unless a different course is pursued to what has taken place heretofore in the conduct of the business of the Joint Committee, and that is not likely to occur now. If the records of that Committee are searched, it will be found that only one meeting—that of a sub-committee—ever took place at which anything approaching to the semblance of a first step being taken towards the organization of a systematic investigation of any branches of the inquiry, that one being allied to the science of architecture, the results of the Committee on other subjects having been *nil*, practically, so far as the writer's knowledge extends at the moment of writing.

These explanations have been given owing to sentiments of dissatisfaction having been expressed by no inconsiderable number of members composing the Committee, some of whom, in consequence of the desultory conversational character of its meetings, eventually held aloof therefrom, and have expressed regrets that they ever allowed their names to appear amongst its list of members. At the time of dismissal, it was intimated to me that the communications and other documents accumulated during the proceedings of the Committee were its (the Committee's) sole property, and ought not to be used, excepting for its purposes. Under such a notification, I have consequently refrained from availing myself of any of the matter so obtained for the purposes of this publication. I hope shortly, however, that such documents will be open to the public generally, and, consequently, to the writer also. If this occurs, and the present *brochure* is favorably received, an opportunity will be open to me for disseminating further information on topics which have been too sparingly noticed or omitted for want of space on the present occasion; ample material existing for such a continuation of the subject, which would also be found more interesting to California readers from the circumstances of its illustrations being drawn from local sources.

To those correspondents who favored the Committee with their individual earthquake experiences, the reasons above given will, it is hoped, suffice as an apology for thus apparently overlooking their interesting communications. The time may perhaps arrive when I may be able to make ample compensation for thus subjecting them, temporarily, to the neglect of silence. It will also fall in place here to express my grateful thanks to those honorary officers of the Odd Fellows' Library who superintend its selection. Had it not been for the judicious manner in which that selection had been made, it is doubtful whether our stock of earthquake literature would have been of the scantest description. With the addition of recent arrivals, the Odd Fellows' Library is now well furnished with the most important works cognate to this subject. To the polite and gentlemanly Librarians, I wish also to publicly convey my compliments for the facilities they have always displayed when referring to the volumes under their care.

Had the wishes of the sub-committee on Finance been heeded, something of a practical character would long before this have been given to the public, for it may be added that the joint Secretaries had notified their willingness to the President of the Joint Committee to report on many matters of interest as early as January last. So far as bricks, stones, the preservation of timber, lime, mortar, etc., are concerned, the writer was as prepared to commence writ-

ing a full report thereon on the day he took office, as he is on this fifth day of May. These subjects, however new they may be to some parties, were anything but new to me.

At the commencement of this treatise it was the intention of the author to have dedicated it to the members of the Chamber of Commerce. Owing, however, to the present paradoxical position of the "Joint Committee on Earthquake Topics" with the former named body, it was conceived that any such complimentary notice might be either misinterpreted or misrepresented. It has, therefore, been deemed more fitting to omit it.

A question has often been put to the writer, and that very frequently of late, whether, in his opinion, the severest earthquake shocks felt in this city approach in severity those which have occurred and been so destructive in South America. The reports of those who were present during the earthquakes of South America last fall, are to the effect that the shocks were not sensibly more severe, but were more continuous, the shocks recurring over comparatively lengthened periods, as compared with those at San Francisco. It ought not to be overlooked in reviewing this phase of the question, that the damage that occurred at the South American cities—like that of Lisbon, in December, 1755—was largely in consequence of the earthquake wave, and the buildings destroyed were almost wholly situated on flat lying alluvium. Notwithstanding the faulty mode of building for an earthquake country adopted in the Iberian peninsula, no damage of consequence took place on that memorable occasion with such as were erected in the upper portion of Lisbon, whose foundations were on limestone. Yet it has been calculated that the great Lisbon shock was felt over more than one-fourth of the earth's surface. The great loss of life which accompanied that disastrous event was principally attributable to the falling in of arched and domed ecclesiastical buildings when densely occupied by devotees. This form of architecture is one totally unfit for a country subjected to earthquakes, unless such vaulted or dome-adorned edifices have these architectural forms constructed of iron framing. In the Kingdom of Naples, the style of building is described as presenting loftiness and thickness of walls; apertures few, but large; square-headed windows and arched doors and gateways, with heavy tiled roofs, of *low pitch*, and with deeply overhanging eaves, characterize the outside. The style of architecture, Roman, with *cinque cento*, along with later and more debased styles of ornamentation. The usually grandiose effect very generally conceals building workmanship of a very inferior quality. Materials: lava, tufa, limestone and brick, usually. Lime is abundant, but the mortar is of very slender cohesion, from too great a proportion of lime and the want of a proper quality of sharp sand.

The general style consists of a coarse, short-bedded, ill-laid rubble masonry, with great thickness of mortar joints, very thick walls, without any attention to thorough binding whatever. The opes of windows and doors often have cut limestone joints, lintels and dressings, which are but ill combined with the rest of the walls. In general, the external faces of the walls are concealed by plaster or rough cast, joists of fir timber, six to nine inches in diameter, placed at about three feet apart. Upon these joists is placed a rough planking of fir, oak or chestnut, and pegged or spiked to the beams, upon which is placed a bed of concrete or beton, six or eight inches deep. The surface is

covered with a layer of red tiles, square or hexagonal, or sometimes plastered over with puzzolano mortar, painted in oil. A floor of this sort weighs from sixty to one hundred pounds to the superficial foot. The roof timbers are crossed with stout sawed laths, upon which are fixed heavy tiles of from three-fourths to one and a half inches thick. Roofing of this character is stated to weigh little less than an equal surface of the flooring noticed.

The style of building of many of the provincial towns is represented as much the same as that found in the cities, but poorer and humbler. The surface limestone, or that taken from the naturally exposed beds of rock, is commonly used to save the labor that would be required to obtain better. Hence the walls are built almost invariably of this coarse "nobby" rubble, in half-rounded blocks, or rather lumps, of stone, of nearly equal length, breadth and thickness, and resembling nothing in form more than irregular loaves of bread. The walls so constructed are almost devoid of masonry bond, and are shaken down into a heap by a shock that would only fissure a well-built and properly bonded structure.

No wonder, under such circumstances, that so many thousands of buildings were destroyed, burying thousands of the inmates in their ruins. It will be seen also from the preceding description that in Italy, as at San Francisco, a large share of the damage occasioned was attributable to an identical cause—*bad mortar*—the difference between the two cases being, that the mortar employed was of inferior cohesive and adhesive powers, owing to using too little sand and too much lime; while at San Francisco the damage was largely increased by employing mortar composed of too small a proportion of lime and too large a proportion of sand.

As I was unable to find room in the body of this treatise to insert the following, I do so here, as it serves to show that it is more economical to use lime mortar alone in place of mixing such mortar with hydraulic cement:

Mr. Ferguson, in a lecture delivered a few months ago, described good mortar as composed as follows:

COST OF CEMENT AND LIME MORTAR.		WEIGHT.
One barrel of lime, per barrel	$ 2 50	200 pounds.
Two barrels of cement at $3 50	7 00	600 pounds.
Six barrels sand at 10 cents	60	1,800 pounds.
Total	$10 00	2,600 pounds.

COST OF LIME MORTAR.		WEIGHT.
One barrel of lime	$2 50	200 pounds.
Four barrels of sand	40	1,200 pounds.
Total	$2 90	1,400 pounds.

The first would cost $7 76 per 2,000 pounds, the second, $4 14—a difference of $3 62, or more than 75 per cent.

A very mistaken view of the interest that ought to be taken in this subject exists amongst the dwellers of different parts of California. The bulk of people consider that the residents of the City of San Francisco and one or two of the more populous places, are the only parties interested in this question. What would have been the case, however, if all the country disturbed in California had been well populated, as it is anticipated to be in a very short period, and well studded with elegant mansions, substantial farm-houses and

dwellings of more humble pretensions? In such a case, where would be the so exclusive interest of San Francisco and a few other cities on this subject? The Campagna of the Roman territory, with the exception of its lying on the sea-board, in place of being amongst inland waters, forms an almost exact counterpart of our swamp and overflowed lands—lands that, no doubt some day, and that not a distant one, will become the great granary and forage-producing ones of the State, and, as a natural sequence, may be expected to teem with an industrial population, requiring dwellings, farmsteads, and appropriate dwellings. Now the question how these latter ought to be built is a most important one. For more than one thousand years the Campagna was the garden of the Roman Empire. It was in the Campagna that its wealthy patricians used to retire to enjoy their "*otium cum dignitate.*" It was of the Campagna that Cato discoursed on agriculture and Virgil versified in his Georgics. The district is even now studded with the massive walls of buildings erected two thousand years ago. It became abandoned ultimately, owing almost wholly to the earthquakes which took place between the fourth and ninth centuries, political troubles at the same time contributing to this abandonment. Yet it need not have been, had residences been built suitable to have met the contingencies required in order to avoid the desolating effects of earthquakes. Owing to neglect, it has again become a miasmatic waste, the terror of travelers compelled to travel the district after nightfall.

In place of viewing earthquake phenomena with superstitious awe, surrounded by mystery, or, as some bigots would, denounce the same as curses or judgments on men's impiety, we ought, by the legitimate exercise of the mental faculties accorded to us, seek the fitting palliatives which such phenomena demand, for the purpose of obtaining security, and humbly accept them as the operations of and parts of a beneficent machinery, as seed-time and harvest.