

## Analysis of the causes of accidents of steel capacitive structures for bulk materials

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The data collected by the author regarding the accident rate of steel capacitive structures for the storage of bulk materials are presented. The materials include both the information written in the specialized literature, the results of the reports of practical structure investigation and review of the causes of accidents and the author's own developments, compiled on the basis of the research results. The presentation is illustrated by photographs of damages and accidents of the investigated structures.

Keywords: CAPACITIVE STRUCTURES, BULK MATERIAL, FAILURE, ACCIDENT

### Introduction

Although the modern concept of designing and building steel capacitive structures for bulk materials, laid in a variety of regulatory documents [1, 2], and professional publications [3], was formed and improved for decades, but the practical experience of operation of such facilities evidence of its imperfection. Capacitive structures prove to be insufficiently reliable and durable, as evidenced by the available statistics of failures and accidents.

Meanwhile, as it is justly pointed out in work [3], silos and hoppers as well as all plate structures are extremely responsible structures. So "... because of the daily downtime of a powerful blast furnace it is lost about 3,000 tons of cast iron, and a large cement kiln - 1,000 tons of cement. Even more may be the losses as a result of the destruction of adjacent structures, caused by violations of the continuity of the plate structure". Therefore, the analysis of the major problems that lead to accidents of such structures is one of the most important tasks on the way to improvement of their quality.

It should be noted that in some cases specialized literature on this subject is quite meager. Many papers provide only fragmentary data and facts [4-7] with a complete picture of the problems are absent. However, this is not due to the high reliability and durability of this class of structures. On the contrary, the statistics of accidents of containers for bulk materials is quite diverse and varied, but it should be noted that some difficulties with its use still exist. The matter is that the silos and, especially, hoppers are often an

essential object of such productions, which are largely of a strategic character, and it means that all the details cannot receive wide publicity. The ethical side of the issue also cannot be ignored, when full disclosure of all details of emergency situations undermines the authority of the construction and design organizations and causes them property damage.

Therefore the author tried to analyze quite clearly but, if possible, avoiding non-desired specification, the overall picture of the capacitive structures accident rate, what is the purpose of this paper. The used literary sources are indicated hereafter in the course of the presentation. The mentioned subject has already been analyzed by the author in his paper [9], but in this publication it is revised and supplemented with a number of new facts that have become available to the author over time.

Note also that, to date, several classifications of structures accident rate have developed. The most successful one is the classification of failures and accidents either for reasons that have caused them, or by character of damage and destruction of elements. However, in terms of engineering, the interest, first and foremost, is in the technical reasons, suggesting further potential intervention in improving the structural system. We shall follow this principle.

### Results and Discussion

One of the specific main causes of failures and accidents of steel capacitive structures for bulk materials is associated with the incorrect definition