AS 3774 Supplement 1—1990

Loads on bulk solids containers—Commentary

(Supplement to AS 3774—1990)

STANDARDS AUSTRALIA

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PREFACE

This Supplement was prepared by the Standards Australia Committee on Loads on Bulk Solids Containers as a commentary of AS 3774, *Loads on bulk solids containers.*

The Supplement provides background information on the Standard.

The paragraphs in this commentary refer directly to the respective clauses in the Standard, e.g. Paragraph C5.3.1 refers to Clause 5.3.1. Where there is no commentary to a clause of the Standard, the clause number does not appear. References are listed as the last item of the Section or Appendix in which they occur.

CONTENTS

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Australian Standard

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SECTION C4 LOAD CLASSIFICATION, LOAD COMBINATIONS, AND LOAD FACTORS

C4.1 GENERAL. The main purpose for the load classification is to enable easy reference to various load types. The load types enumerated in Table 4.1 are typical in this class of structure, but each structure should be individually treated and any additional load types considered.

C4.2 LOAD COMBINATIONS. Each element of the structure should be designed for loads and load combinations appropriate to its function. Upper and lower characteristic values of loads should be applied to each structural element in considering its limit state of strength and serviceability.

The probability of all loads in a load combination acting at their upper characteristic values should be considered in view of the fact that all loads are randomly variable. In the absence of routine methods for statistical probabilistic analysis, Section 4 gives general guidance for combining loads.

Special care is needed to identify structural elements which are prone to strength reduction when one or more load types in the load combinations drops to its lower characteristic value. Typical examples are—

(a) walls of cylindrical containers under axial loads when the lateral pressure from the bulk solid is taken into consideration in the buckling analysis; and

(b) anchor bolts under uplift loads due to environmental loads.

C4.3 LOAD FACTORS. Two sets of load factors are specified: one set for strength design and another for serviceability design.

The values of load factors given in Clause 4.3 reflect the probabilistic concepts of the ultimate limit states codes in that they vary in accordance with the classes of loads included in each particular load combination. Since it is impossible to cover every conceivable load combination in a wide variety of containers, the designer should carefully investigate all special conditions that may arise and apply appropriate values of load factors.

SECTION C6 DETERMINATION OF NORMAL SERVICE LOADS (GROUP B)

C6.1 RELEVANT PROPERTIES OF STORED BULK SOLID.

C6.1.1 General. The mechanical properties of the stored solid should be determined experimentally wherever possible. These experiments may be conducted to find the mean value of properties, in which case the variability is assessed using the procedures of Clause 3.4. Alternatively, a more extensive set of experiments may be undertaken to establish the variability of the material. The necessary procedures are set out in Clause 3.4.

C6.1.2 Unit weight of bulk solid. All loadings are increased when the unit weight of the stored bulk solid is increased. The design should therefore be based on the highest expected value. Many solids consolidate under stress and with time. The design unit weight should recognize possible differences between laboratory measured values and service conditions.

C6.1.3 Angle of wall friction. It should be recognized that wall friction is an interaction between the stored solid and the wall. It may be affected markedly over the long term by the sliding of the stored solid, or by chemical interactions of the wall with the stored solid. Polishing, rusting, corroding, vibrations, and other effects should be considered when assessing the possible range of wall friction coefficients to be used in design.

The rule concerning liners is included because liners are sometimes destroyed or removed during the course of the container's operation, and have occasionally not been fitted, though considered in the design. The structural integrity of the container should not depend on the presence of a liner of the assumed properties.

C6.1.4 Effective angle of internal friction. The angle of internal friction used throughout this Standard is the effective angle of internal friction, as defined in Appendix C. Where the material possesses a high cohesion, so that the effective angle of internal friction is very much higher than the simple tangent angle of internal friction, specialist advice should be sought. In calculations in which the lower characteristic value of internal friction is required, the tangent value may be more appropriate.

C6.1.5 Consistent material properties. The loads on a container wall lead to stresses in the wall. Because the container wall is two-dimensional (flat or curved), stresses in more than one direction are often induced. These stresses usually interact, leading to a condition either more or less serious than when no interaction occurs. In such an interaction, it is the intention of this Standard that a single definable material be used for the purposes of assessing all load effects which contribute to the interaction.

Thus, for example, when a cylindrical steel container is being designed, wall friction leads to axial compressions in the wall, and internal pressures lead to circumferential tensions. The circumferential tensions can increase the strength of the container wall against buckling in axial compression. It is therefore necessary to find the minimum reliable internal pressure which is coexistent with the axial compression. The minimum internal pressure is found using Clause 6.2.1.9. It is the intention of this Standard that the same values of material properties should be used in calculating both the maximum axial compression and the minimum coexistent internal pressure. Similarly, when the wall is being designed against bursting, the coexistent axial compression reduces the strength. It is the intention of this Standard that the same values of material properties should be used in calculating both the maximum internal pressure and the maximum coexistent axial compression.

Nevertheless, it should be recognized that different material properties should be used when assessing the strength of the structure against different dominant failure modes. Thus, the material properties used to assess the strength against a bursting failure (in the presence of some axial compression) may be different from those used to determine the strength against failure under axial compression (in the presence of some internal pressure).

The aim is to produce consistent calculations which would be valid if the container were filled with a single homogeneous material. It is supposed that these material properties may change from time to time, as the container is filled and discharged, leading to different loading conditions.

The stipulation that the angle of wall friction cannot exceed the angle of internal friction merely states that the material would slide on itself near the wall if the wall becomes rougher than the internal friction in the material. Experimental observations indicate that the dynamic angle of internal friction is usually slightly less than the static angle of internal friction. Thus, once sliding has begun internally in the solid, the rupture plane is often maintained, and the effective value of ϕ_i is slightly reduced.

C6.2 INITIAL LOADS ON SYMMETRICALLY FILLED CONTAINER WALLS (LOAD TYPE B.2). The loads exerted by bulk solids on containers depend on whether the container is being filled, is being used for storing after filling, is being discharged, or is being simultaneously filled and discharged. In general, the highest loadings on the structure occur when the container is full, irrespective