



Fachartikel

## **The Development of Industrial Silos Throughout the World During the Last 100 Years**

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It was exactly 100 years ago, in 1881, that Baker started to investigate the lateral pressures exerted by a solid. Nevertheless it is said that the initial steps towards the automation of flour mills were taken with the construction in 1780 of the first bucket elevator.

In England in 1882 Roberts carried out the first tests to determine lateral and vertical pressures in silos. He built a square silo 3 m wide and 15 m high together with models for laboratory tests. The results of the tests showed that pressures on the bottom attain a maximum value after the level of the material reaches a height equal to twice the width of the bin. Lateral pressures follow the same procedure. Moreover, there are friction forces on the walls which transmit considerable compression forces.

These tests caused a sensation in their day since the calculation of silos had been carried out on the basis of hydrostatic pressures; that is to say the value of both the horizontal and vertical pressures being the product of height multiplied by density. No friction forces were considered and therefore the weight of the ensiled material rested entirely on the bottom of the silo.

In 1895 Janssen in Germany established the mathematical expression of the tests carried out by Roberts. Lateral pressures are of an exponential type reaching

maximum value at a height not exceeding twice the width of the silo. Vertical pressures are obtained by using the value  $K = P_h/P_v$  for the ratio between horizontal and vertical pressures.  $K$  takes on various values, and in some cases complicated formulae have been used to calculate it.