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Research paper

The determination of the mechanical strength of tablets of different shapes

Peter N. Davies [a], Harry E.C. Worthington [a], Fridrun Podczeck [b], J. Michael Newton [c,*]

[a] *Roche Products Ltd., Herts, UK*
[b] *University of Sunderland, School of Health, Natural & Social Sciences, Sunderland, UK*
[c] *Department of Mechanical Engineering, University College London, London, UK*

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Abstract

The aim of the study was to investigate the influence of the platen design, on the evaluation of the mechanical strength of tablets of different shapes in terms of the potential of ensuring reproducible failure mechanisms and deriving their tensile strength. Tablets which were circular, square or hexagonal in shape were prepared at a range of formation pressures each from microcrystalline cellulose (Avicel PH102), a direct compression anhydrous β-lactose (DCL 21) and dicalcium phosphate dihydrate (Emcompress) with a reciprocating single punch tablet machine. The mechanical strength of the tablets has been determined with a three-point bending test and by applying a diametral load across the edges of the tablets with platens of different designs. Many of the tablets tested in three-point bending did not fail in tension. However, with platens to which semi-circular rods of radius 3.0 mm were attached and vertically aligned, a test procedure was provided with which a wide range of tablets tested failed in tension, i.e., split into two halves. Where this occurred it was possible to calculate the tensile strength from the breaking load. Although the value of the tensile strength obtained with such platens was generally lower than that obtained for circular tablets when flat platens were used, the ability to be able to use this new configuration for all the tablet shapes provided a practical system for a range of tablet shapes. The tablets of the three shapes tested here were found to have equivalent values for the tensile strength when formed at the same compaction pressure for the three materials tested.

Keywords: Diametral compression; Mechanical strength; Tensile failure; Platen design

1. Introduction

The requirement of the FDA to be able to identify tablets visually and the restriction of the worldwide acceptability of colours have led to the production of tablets with different shapes as a means of identifying the product. This has the potential to lead to problems in the determination of the mechanical properties of the tablets as a QC procedure. The characteristic measure of strength, usually referred to in the pharmaceutical literature as "hardness", is at variance with the literature of material science where the value of "hardness" is restricted to tests, which usually involve the pressing of an indenter into the specimen to provide a measure of plastic/elastic properties of the material. The correct terminology should be "mechanical strength" but this does present a problem with pharmaceutical technologists as the term "strength" is usually used to indicate the drug content of the tablet. The term "strength" in materials science terms is usually associated with a failure mechanism, i.e., compressive, shear or tensional failure. Most materials are weakest in tension and therefore it is this value which is the easiest to determine. The conventional materials science approach to the determination of the mechanical strength of materials is therefore to determine the tensile strength, usually by direct pulling of a specimen. Even here there are problems if the materials are brittle, as such materials are difficult to test by the

* Corresponding author. Department of Mechanical Engineering, University College London, Torrington Place, London WC1E 7JE, UK. Tel./fax: +44 207 7535869.
E-mail address: michael.newton@pharmacy.ac.uk (J.M. Newton).

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pulling approach and therefore indirect methods are often used. The materials that are able to form tablets tend to have varying degrees of brittleness and therefore indirect methods of measurement would be useful especially if they could be undertaken on the tablets themselves rather than artificially prepared specimens. The indirect methods, which have the potential to be used for compacted powders, have been reviewed by Stanley [1]. He clearly points out that there is no single value of the tensile strength of a compacted powder but a range of values, which depend on a number of factors, the most important being the method of application of the load.

The mechanical strength of tablets has been determined, for a considerable number of years for the simple conventional circular tablet by pressing the tablet by some means diametrically between flat platens and recording the force necessary to break the tablet, i.e., an indirect test. The methods of applying a consistent load and recording the force have improved in recent years but there is little concern about the factors which influence the results or the need to ensure that the fracture of the tablet takes place in a consistent manner. Even for a simple configuration of a flat circular specimen, the material of the tablet, the type of platens and the inclusion of material between the specimen and the platen [2,3] and the rate of application of the force [4,5] can all influence the load at which the tablet fails and the mechanism which causes the failure to occur. These changes result from the changes in the stress distribution within the tablet, which if correct, can result in the fracture of the specimen in tension and allow the derivation of the value of the tensile strength for the fracture load and the tablet dimensions [6]. While used by the pharmaceutical industry for a considerable number of years, the understanding of the stress distribution and its importance comes from other industries and areas of science. The need for an understanding of these factors was emphasised by Stanley [1] in his review of the determination of the strength of compacted powders. If the stress distribution changes so could the values of the breaking load and the mechanism of failure, which in turn will influence the derived value of the tensile strength. Stanley [1] went on to describe the concept of the 'Failure Envelope' to illustrate how the various strength values from different methods of stress application can be co-ordinated into a single graphical representation. Podczeck [7] has described the application of this approach to the characterisation of the mechanical properties of a pharmaceutical material. This is a more logical and scientific way to approach the problem rather than the proposal of empirical equations for the expression of strength as recently suggested [8].

Failure to take the correct stress analysis into consideration can have important implications for the understanding of what is happening in terms of tablet strength of specimens of different shape. This is illustrated by the paper of Podczeck and Newton [9], where it was pointed out that the approach used by Hiestand et al. [10] and Hiestand and Smith [11] to develop his concept of evaluating the brittleness of pharmaceutical materials was flawed by the failure to use the correct equation to determine the tensile strength of a specimen with a pre-formed hole.

Of particular importance in the application of the diametral test system is the contact area between the specimen and the testing device. With a simple circular tablet, a flat platen will automatically produce a contact controlled mainly by the relative deformability of the specimen and the platen [12]. Even here, the platen shape had to be modified to a semi-circular shape to induce a consistent failure mode in circular specimens of graphite, with the need for a modified solution for the stress analysis [13]. A simple change in the shape of the tablet, e.g., to a square compact, will result in a totally different contact configuration, and the flat platens of uncontrolled dimensions would not be appropriate. Berenbaum and Brodie [14] studied the use of square indenters of different relative width, in the fracture of cube specimens with a photo-elastic technique. They established the stress distributions involved but to use such a system regularly would require different indenters for different sizes of specimens. An alternative would be to load a square specimen across the diagonal, for which a stress solution exists [15], but this would not be an easy test to perform. There are stress solutions for diametral loading of elliptical shapes, e.g., Appl [16], but once the length of the ellipse increases beyond a certain point, it would be preferable to move towards a bending test for which Stanley [1] provides an analytical solution. When the tablets are ''capsule shaped'' again the bending test, for which an analytical solution is available [17], is the best approach. When there is a link to the actual use, as with chewable tablets [18] again the use of a bending test makes practical sense.

The implications for changing tablet shape are therefore numerous. There are clearly a large number of variables involved in addition to punch shape, such as the material used, the method of compaction and the strength testing system. The first stage of the process is described here, where the testing of tablets, which are approximately equi-dimensional in length and width, namely ''square'' and ''hexagon'' shaped tablets is considered for three direct compression materials. The conventional tablets in the form of right circular cylinders are used as a comparison.

2. Materials and methods

2.1. Materials

The test materials were selected to represent direct compression materials, which are different in their mechanical properties, to check the influence this could have on the test procedure. Microcrystalline cellulose USP/NF was Avicel PH102 grade supplied by FMC (Little Island, Cork, Ireland) and was used as supplied. The β-lactose anhydrous was Lactose DCL 21 supplied by International Pharma, Veghel, Netherlands and dibasic dicalcium phosphate dihydrate was supplied as Emcompress by Forum Chemicals, Reigate, UK. The powders were separated into a size fraction between 75 and 250 μm by sieving using a tapping sieve shaker (Pascall Engineering Ltd., Crawley, West Sussex, UK) fitted with British Standard sieves. Magnesium stearate was of BP quality and was supplied by Durham Chemicals, Birtley, Co Durham, UK.

2.2. Methods

2.2.1. Preparation of the tablets

Twenty grams of magnesium stearate and 1980 g of each of the materials were mixed in a 6.4l Y-cone blender, type 165 (Apex Construction, Dartford, UK) for 3 min. The resultant mixtures were stored double wrapped in polythene bags with activated clay desiccant placed between the bags.

2.2.2. Preparation of tablets

The shapes and dimensions of the punches used to prepare the tablets are given in Table 1. I Hollands (Long Eaton, UK) manufactured the punches from KE960 steel with a surface hardness of 570–620 Vickers pyramid number. The diameter given for the square and hexagon shaped punches given in Table 1 is the inscribed circle. The clearance between the punch and the die was 0.05 mm for the upper punches and 0.03 mm for the lower punches. The corners of the square and hexagon punches were machined to give a radius of curvature of 0.5 mm. The punches and dies were fitted to an F3 reciprocating single punch tablet machine (Manesty Ltd., Speke, UK). The machine was instrumented with piezoelectric load cells type 9031 and charge amplifiers type 5054A (Kistler Instruments Ltd., Alton, Hants, UK). The compaction forces were recorded by transferring the data to an IBM PC XT fitted with a 12-bit analogue to digital converter. The compacts were prepared by running the machine under power at the rate of 1 tablet per second and the tablets were collected sequentially so that each tablet could be identified against a formation force. The compression was carried out in a room where the temperature was controlled between 17 and 22 °C and the humidity between 30% and 40% RH. An attempt was made to standardise the quantity of materials used in the different shaped tablets by calculating the weight of tablets at known thickness and zero porosity, from knowledge of the dimensions of the tablets and the apparent particle density of the materials determined with an air comparison pycnometer (Model 930 Beckman Instruments, Glasgow, UK). The values used for the different punches are given in Table 2. All the compacts were numbered and placed in air tight screw capped amber bottles stored in the same room in which the tablets were manufactured, until required for strength testing, always at least 2 weeks after manufacture. The weight ±0.001 g and thickness ±0.0001 mm (Mercer dial gauge micrometer, Mercer, Leicester, UK) was recorded and only those tablets with a variation in pressure, weight and thickness of less than 1% were tested.

For the different materials and punch types, the range of pressures, which could be used to form tablets which failed in tension when tested, varied. At low pressures tablets were of insufficient strength to be handled, while at high pressure, tablets capped or did not give tensile failure.

Table 1
Punch shapes and sizes

Shape	Size[a] (mm)
Circle	20
Circle	10
Square	20
Square	10
Hexagon	20
Hexagon	10

[a] Size is defined here as the diameter of an inscribed circle.

Table 2
Compression weights and apparent particle densities of materials used to prepare tablets

Material	Size (mm)	Zero porosity thickness (mm)	Compression weight (mg)			Apparent
			Circle	Hexagon	Square	particle density[a] (kgm^{-3})
Avicel PH102	20	2.0	980	1081	1248	1560(15)
		2.8	1372	1513	1747	
	10	2.0	245	270	312	
		2.8	343	378	437	
		3.2	392	432	499	
		3.8	441	486	499	
Emcompress	20	2.0	1445	1593	1840	2300(25)
		2.8	2023	2230	2576	
	10	2.0	361	398	460	
		2.8	505	557	644	
		4.0	722	796	920	
		6.0	1083	1194	1380	
Lactose DCL 21	20	2.8	1363	1504	1736	1550(15)
	10	2.8	341	376	434	

[a] Mean of three values with standard deviation in brackets.

The limits of these pressure ranges were not identified with any degree of accuracy and the pressure ranges are not therefore precise, nor always inclusive for all tablet shapes.

2.2.3. Testing the mechanical properties of the tablets

The mechanical properties of the tablets were determined with a CT40 (Engineering Systems, Nottingham, UK). Different platen designs were used for the diametral compression test as illustrated in Fig. 1 and are as follows:

(a) Flat; 15 mm diameter flat faced steel platens (those normally fitted to the instrument).
(b) Semi-circular; a 3.0 mm radius semi-circular steel rod was attached to the 15 mm diameter flat platens vertically aligned on the lower and upper platens.
(c) Pointed; lower and upper platens were fitted with triangular cross-sectioned steel rods (with a 90° angle point and height of 3.0 mm) aligned vertically.
(d) Notched platens; standard 15 mm diameter flat lower and upper platens had grooves vertically aligned cut into their surface to allow the square and the hexagon tablets to be tested diagonally and across corners. The grooves for the square tablet had a 90° angle, while those for the hexagon had a 120° angle, both with a depth of 2 mm.

The tablets were placed vertically between the platens. The square and hexagon tablets for systems (c) were aligned so that the rods were at the mid-point of a side, unless otherwise stated. The upper platen descended at a rate of 1 mm /min and the calibrated load cell was fitted with a peak hold device to record the load at failure. Ten tablets were tested under each set of loading configuration. The values of the breaking load of those tablets, which failed in tension, were converted to a tensile strength from a consideration of the tablet diameter (the inscribed diameter for the square and hexagon shaped tablets), thickness and breaking load, using the standard equation for disc shaped specimens [3]. The graphs plotted represent the mean value for the ten tablets with the error bars being the standard deviation. Where the error bars do not appear in the graph, they are within the dimensions of the symbols.

A three-point loading system was fitted to the CT40. The rig consisted of two 3.0 mm diameter steel rollers, which could be placed at known distances apart on the load cell. A standard 15 mm diameter upper platen was fitted with a 3.0 mm diameter steel rod such that it was parallel to the lower rolls. This conforms to the configuration of Fig. 2a in Stanley [1]. The tablets were placed horizontally on the lower rolls mid way between the centre and the edge of the tablet and the upper platen was brought down at a rate of 1 mm/min until the tablet fractured. From knowledge of the distance between the lower rolls, the tablet thickness and the breaking load the tensile strength could be calculated [1].

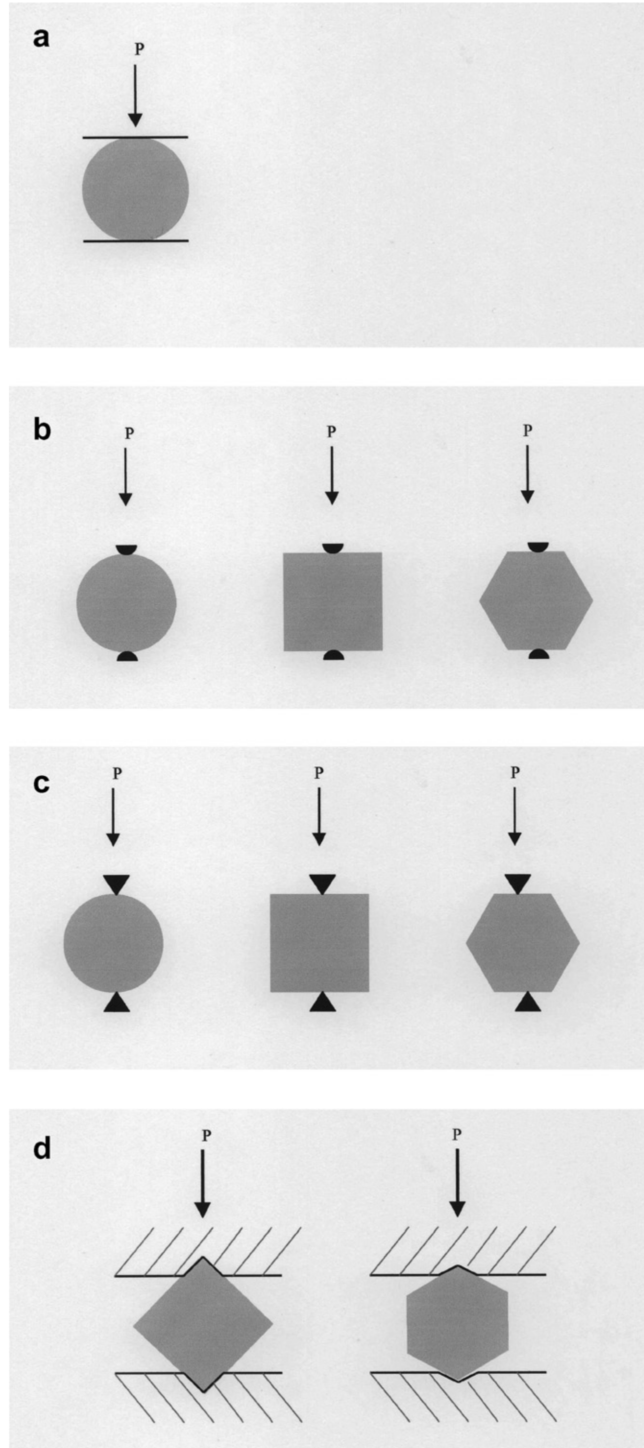

Fig. 1. Platen designs used in tablet strength testing. (a) Flat platen (b) platens fitted with 3.0 mm radius semi-circular rods (c) pointed platens (d) platens containing either 90° or 120° notch.

3. Results and discussion

The first question that arises when considering the mechanical properties of tablets of different shape is does the change in shape have an influence on the tablet structure? An evaluation of such a question would involve a

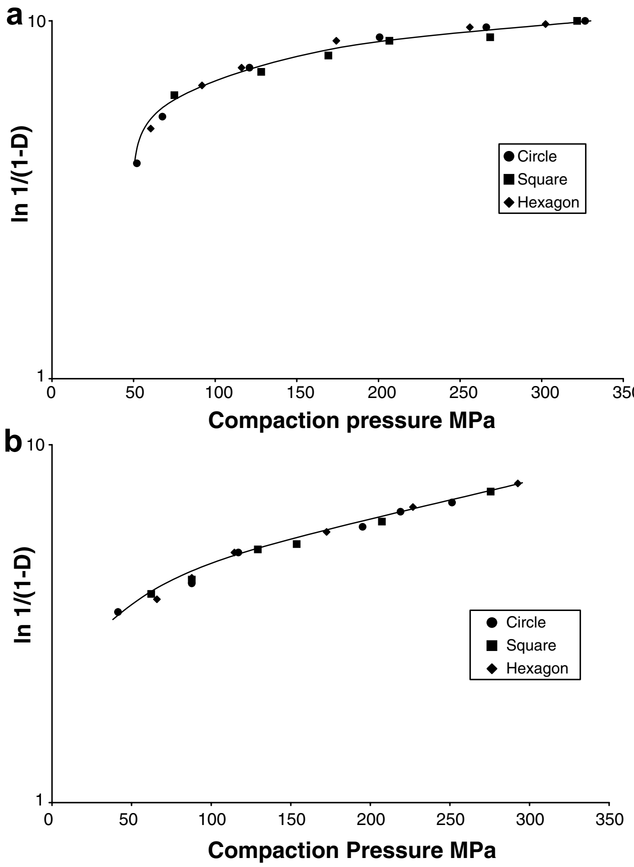

Fig. 2. Heckel graphs for Avicel PH102 (a) and Emcompress (b) for circular, square and hexagonal tablets.

considerable amount of work as methods of determining the internal structure of tablets at a level of detail associated with the process of crack propagation, which would be required for a fracture mechanics approach, are not readily available. On a larger scale however if the changes in the tablet density assessed from the dimensions, weight and material density after compaction are plotted as a function of compaction pressure as suggested by Heckel [19], this should reveal any major changes. When this was undertaken for the circular, square and hexagonal tablets prepared from Avicel and Emcompress with an equivalent diameter of 10 mm, the graphs were the same for each of the three tablet shapes for the two materials tested (see Figs. 2a and b). The same was true for the circular tablets prepared from different initial weights of these materials. Thus on a macroscopic scale, the tablets of different shape and thickness have approximately the same structure and therefore, any changes in strength will be due to differences in tablet shape or internal microstructure.

3.1. Three-point loading

During initial experiments it was observed that several of the tablets tested did not always break in tension, i.e., along a centreline between the two lower rolls. The line of failure often travelled from one of the lower rolls to the centre of the upper surface of the tablet, i.e., the loading point. Modifications were made to the position of the lower rolls but even then, the fracture line was not always consistent. As one of the aims of the work was identifying a system that was consistent, this method of testing was not investigated further in terms of identifying the regions of tablet shape and compaction pressure over which a satisfactory performance could be achieved. For certain systems, it has proved possible to obtain tensile failure by this approach so it should not be dismissed out of hand as a possible solution to test a particular formulation.

3.2. Diametral compression

3.2.1. Circular tablets tested with flat, pointed and semi-circular platens

The first system tested was to assess the influence of changing the contact between the platens and the simple right circular cylindrical tablets. The results of the tests with 20 mm diameter Avicel and Emcompress tablets with flat, pointed and semi-circular platens (configuration shown as a, b and c in Fig. 1) are shown in Figs. 3a and b. All the tablets failed in tension, i.e., failed along a central break line. Hence conversion of the breaking load to a tensile strength is valid. The results illustrate that the value of the tensile strength at a given compaction pressure increases as the platen changes from pointed to semi-circular to flat. The reason for the low value is probably associated

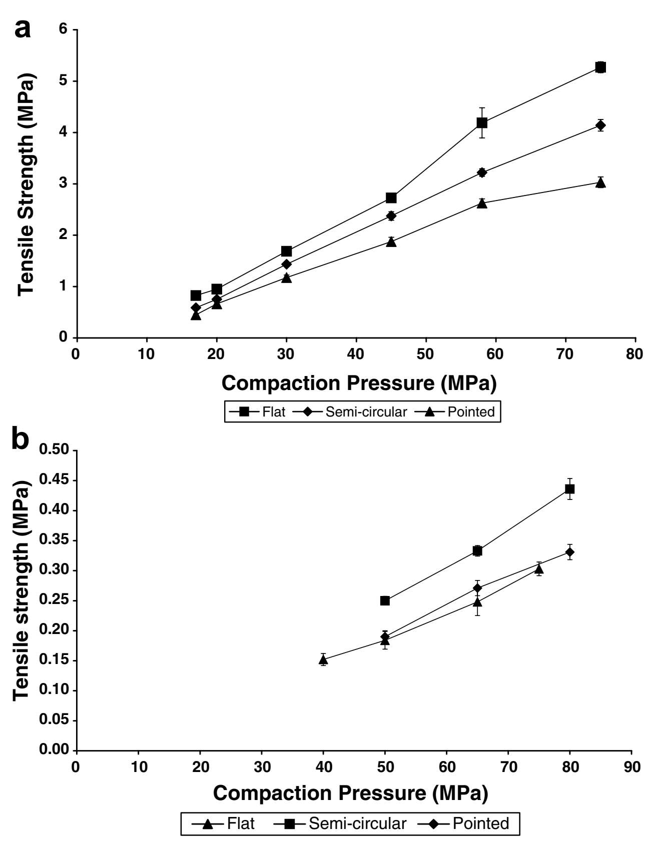

Fig. 3. Tablet tensile strength as a function of compaction pressure for 20 mm circular tablets of 2 mm thickness at zero porosity, tested with different platens for (a) Avicel PH 102 and (b) Emcompress.

with the pointed platens providing 'line loading' which results in the lowest value for the breaking of the system, while spreading the load results in an increase in the value of tensile strength [3,12]. As the pointed platens were the most difficult to use in terms of placing the tablets in position and had a tendency to cut into the tablets, they were omitted from tests with other tablets.

When the flat and semi-circular platens (Figs. 1a and b) were used with the previous materials plus two types of direct compression lactose and 10 mm diameter tablets, the results in Figs. 4a–c were obtained. Note that the values for the tensile strength of the 20 and the 10 mm tablets formed at the same compaction pressure are not equivalent. This has been previously reported for tablets prepared from acetylsalicylic acid [20], and is associated with the phenomenon that has been known for some time, that the volume can influence the tensile strength of brittle specimens [21]. Again there is clear evidence that the semi-circular platens resulted in a lower value for the tensile strength. This effect could be due to the difference in contact area associated with the difference in platen design. To investigate this, tablets were loaded to approximately 90% of the fracture load and the width of the contact between the tablets and the platens measured with a cathetometer (model 2202 Precision Tool and Instrument Ltd., Welwyn, UK). The results are set out in Table 3 and clearly show that for all the tablets, there is a greater contact width when the flat as opposed to the semi-circular platens are employed. For tablets prepared from Avicel, as the formation pressure increases, so does the contact width. This shows that in spite of the increase in the rigidity of the tablet as the formation pressure increases the deformation is still possible, as the tablet is stronger and requires increased forces to induce failure. For β-lactose DCL 21 and Emcompress, the opposite effect occurs in that the contact width decreases with formation pressure. Here the increase in rigidity of the tablets appears to be less than the increase in strength induced by the higher compaction pressure. There is also a clear difference in the contact width for the deformable Avicel and the more rigid materials of Lactose and Emcompress.

3.2.2. Circular tablets of different thickness tested with semi-circular platens

A further factor, which could be important, is the thickness of the tablets. For lactose monohydrate tablets tested with flat platens, the tensile strength was found not to be equivalent for all tablet thicknesses [22]. As the compaction pressure increases over the range of pressures studied, the tablet thickness will decrease over a small range. The question arises, would the semi-circular platens still perform in a satisfactory manner if there were significant changes in tablet thickness? To test this, 10 mm tablets were prepared from Avicel and Emcompress with different weights of material and their breaking loads determined with the semi-circular platens (Fig. 1b). The results in Figs. 5a and b show that for these two materials, the tensile strength/compaction pressure graphs for the different weight tablets

Table 3
Contact widths between circular compacts and the platens determined by cathetometry

Material	Diameter (mm)	Compaction pressure (MPa)	Platen shape	Contact width (mm)	
				Mean	SD
Avicel PH102	20	31.8	Flat	2.19	0.15
		47.7	Flat	2.54	0.09
		63.5	Flat	2.54	0.18
		81.2	Flat	2.54	0.15
	20	31.8	Semi-circular	1.39	0.20
		47.7	Semi-circular	1.36	0.40
		63.5	Semi-circular	1.68	0.22
		81.2	Semi-circular	1.51	0.23
	10	186.0	Flat	1.36	0.15
		243.0	Flat	1.60	0.19
		310.0	Flat	1.67	0.17
	10	186.0	Semi-circular	1.14	0.29
		243.0	Semi-circular	0.93	0.38
		310.0	Semi-circular	0.95	0.29
Lactose DCL 21	20	49.2	Flat	2.28	0.51
		64.3	Flat	2.05	0.41
		78.1	Flat	1.89	0.62
		49.2	Semi-circular	1.07	0.30
		64.3	Semi-circular	1.07	0.28
		78.1	Semi-circular	0.74	0.34
Emcompress	20	48.4	Flat	1.95	0.47
		64.0	Flat	1.79	0.40
		48.4	Semi-circular	1.01	0.21
		64.0	Semi-circular	1.01	0.29

SD, standard deviation of five determinations.

fall on a common line. The ranges of tablet thickness considered are from 2.0 to 3.8 mm for Avicel tablets and from 2.0 to 6.0 mm for the Emcompress tablets. For tablets prepared from Avicel, the highest values for R^2 (the linear determinant) and of F (the variance ratio) were obtained with a cubic relationship between the two variables. By the same criteria, a linear relationship gave the best correlation for tablets made with Emcompress. Thus this design of platens is suitable for testing tablets of different thickness.

3.2.3. Circular, square and hexagonal tablets tested with semi-circular platens

The use of the 15 mm flat platens (Fig. 1a) would present a complete contact with the 10 mm square and 10 and 20 mm hexagonal tablets but only 75% with the 20 mm square tablets. Also, as there is no readily available stress solution for such a configuration, it was considered to be inappropriate to use this type of platens. The semi-circular platens (Fig. 1b) were therefore used to assess the strength of the three shapes of tablets, circular, square and hexagonal in the 10 mm format. When this system was used, all the tablets reported here failed in tension and hence the breaking load was used to calculate the tensile strength of the tablets, using the same standard equation for a circular tablet of equivalent diameter of the inscribed circle for the square and the hexagonal tablets. The results for 10 mm equivalent diameter tablets are presented in Figs. 6a–c for the three materials. These show that in many cases, the value of tensile strength of the tablets of different shape is very similar for the same compaction force. A common regression line was obtained for each of the materials tested. The best correlation as determined by the largest R^2 and F values was a cubic equation for the tablets prepared from Avicel, whereas for the DCL lactose and the Emcompress tablets, a power law equation provided the best relationship. Thus while the values of the tensile strength for the circular tablets with semi-circular platens, see Fig. 4, are slightly lower, they are reproducible and the use of this type of platens allows the testing of tablets of a range of dimensions. Again the 10 mm tablets were not equivalent in tensile strength to the 20 mm diameter tablets.

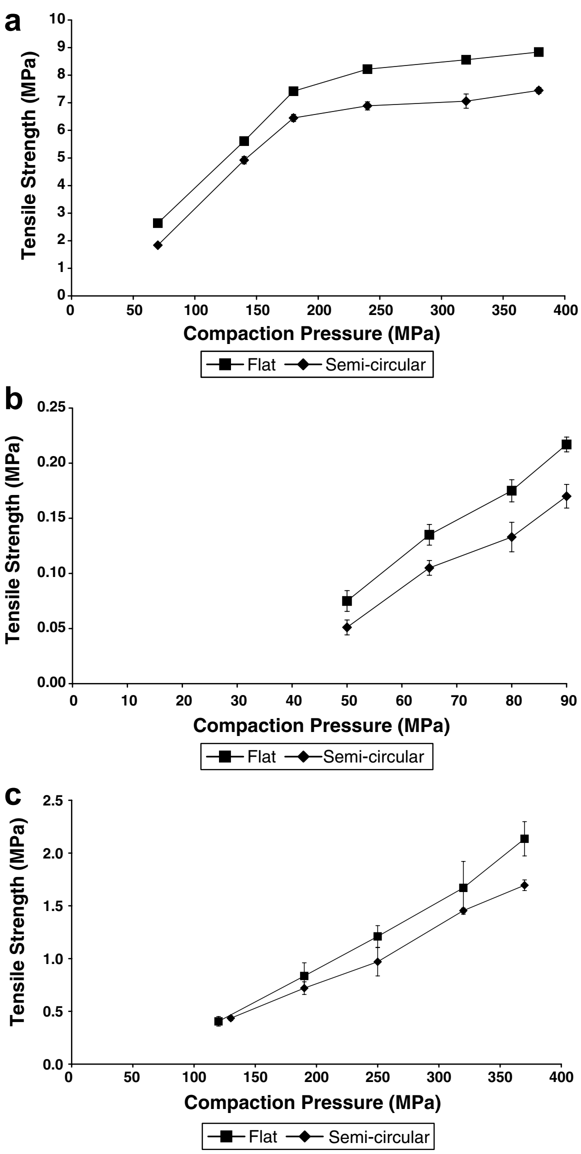

Fig. 4. Tablet tensile strength as a function of compaction pressure for 10 mm diameter tablets of 2 mm thickness at zero porosity, tested with different platens for (a) Avicel PH102, (b) β-lactose DCL and (c) Emcompress.

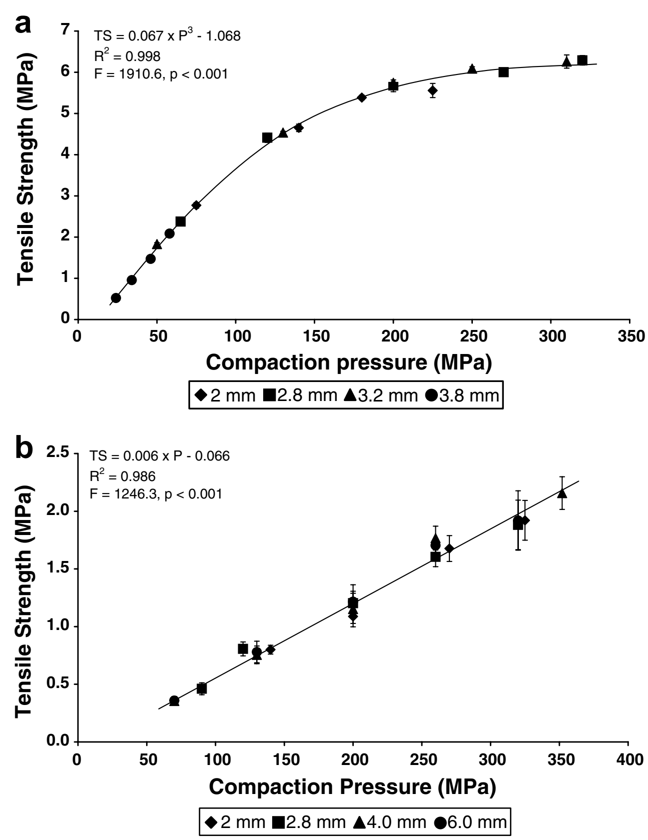

Fig. 5. Tablet tensile strength, as a function of compaction pressure for 10 mm diameter tablets of different thickness at zero porosity, tested with semi-circular platens, for (a) Avicel PH102 and (b) Emcompress.

3.2.4. Square and hexagonal tablets tested with semi-circular platens placed off centre

For circular tablets, the tablets are always tested across the diameter with platens fitted with semi-circular rods. For the square and the hexagonal tablets however, it is possible to place the semi-circular rod at different points on the flat side. The same area of contact will be achieved but the different position may result in different stress distribution within the tablet. To test the effect of a change in position of the loading system, 10 mm square tablets prepared from Emcompress were tested by placing the tablet such that the semi-circular platen provided a load along the central position and 2.5 mm from the central line. The results in Fig. 7 show that the resultant values for the tensile strength were equivalent. A common regression correlation was identified as being linear, for the two sets of conditions. The slope and intercept values corresponded to those for the tablets made with different quantities of Emcompress, see Fig. 5b.

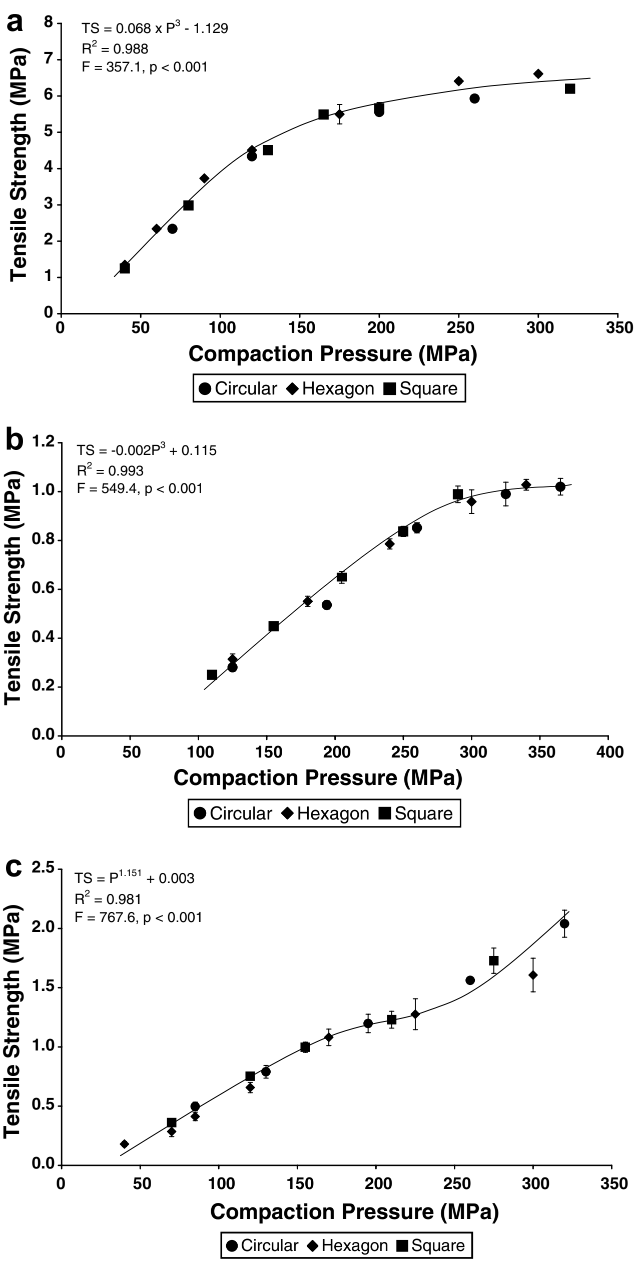

Fig. 6. Tablet tensile strength as a function of compaction pressure for (a) Avicel PH102, (b) β-lactose DCL and (c) Emcompress tablets of 10 mm equivalent diameter and 2.8 mm thickness at zero porosity, tested with semi-circular platens.

3.2.5. Square and hexagonal tablets tested with notched platens

To avoid the need to balance the square and hexagonal tablets on the semi-circular platens, platens were prepared with notches so that the square and the hexagonal tablets could be loaded across a diagonal (Fig. 1d). When tested by this system the 10 mm square and hexagonal tablets failed in tension. If the length of the line between the contact points is used to replace the diameter in the standard equation, then the values of the tensile strength as a function of the compaction pressure are comparable with those obtained with the semi-circular platens, see Fig. 8. The best regression equation for the square and hexagonal Avicel tablets (Figs. 8a and b) was again found to be a cubic expression. In the case of Emcompress hexagonal tablets (Fig. 8c), a quadratic expression provides the best correlation but this seems to be strongly influenced by the low strength tablets. At the higher compaction pressure, the usual linear correlation appears to apply. This configuration therefore appears to offer another mode of testing but is less flexible in that different notches would be required for different tablet size and shapes.

4. Conclusions

A three-point loading test configuration does not appear to provide a universal test system for tablets that are approximately equi-dimensional in shape in two dimensions for the materials tested. The diametral compression test appears to offer a procedure with wider

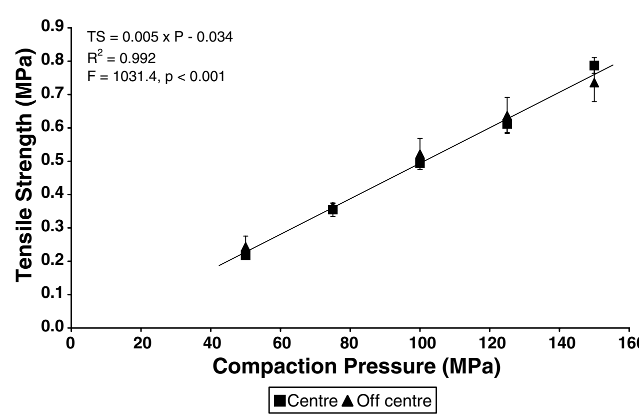

Fig. 7. Tablet tensile strength as a function of compaction pressure for 10 mm square tablets of 10 mm side length and of 2.0 mm thickness at zero porosity prepared from Emcompress. Tablets tested with 2.5 mm radius semi-circular platens placed centrally and 2.5 mm from the central line.

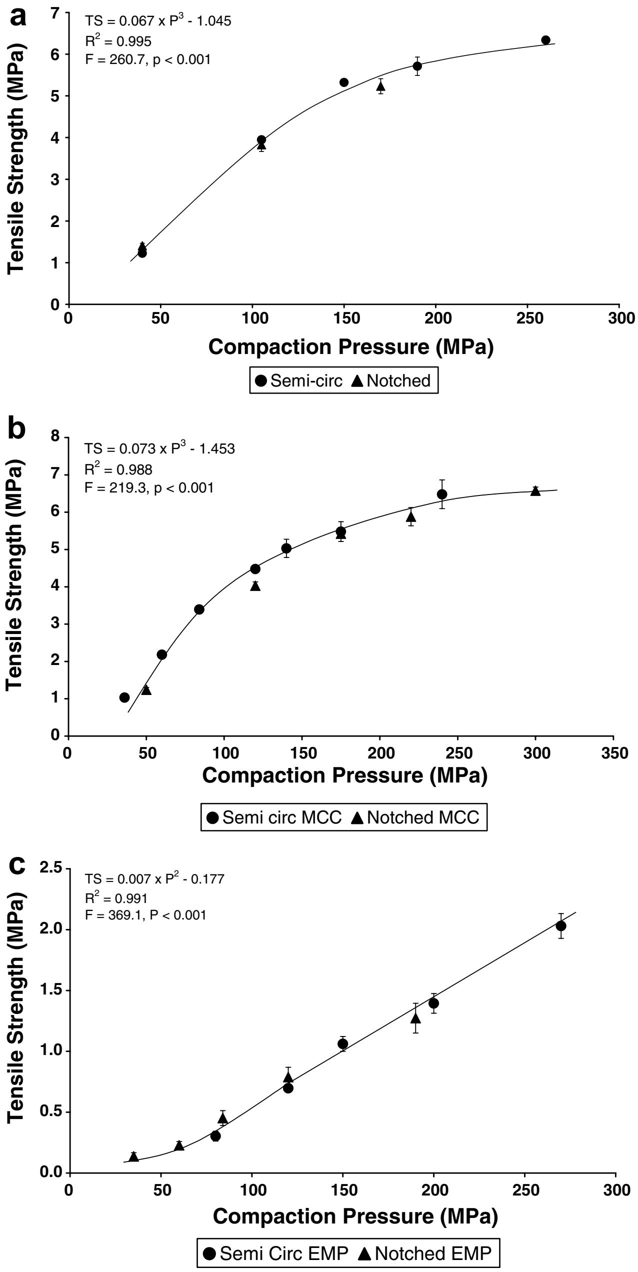

Fig. 8. Tablet tensile strength as a function of compaction pressure for tablets tested with platens 2.5 mm radius semi-circular rods and platens containing a suitable notch. (a) Square tablets prepared from Avicel PH102 with 10 mm square punches and 2 mm thickness at zero porosity. (b) Hexagon tablets prepared from Avicel PH102 with10 mm hexagon shaped punches to give 2.0 mm thickness at zero porosity and (c) hexagon tablets prepared from Emcompress with 10 mm hexagon shaped punches to give 2.0 mm thickness at zero porosity.

potential. The application of the diametral compression with small semi-circular platens providing contact between the tablets and the platens has been found to be a suitable test configuration for the determination of the mechanical strength of tablets prepared with circular, square and hexagonal punches and from direct compression materials on a reciprocating tablet machine. The resultant fracture of the tablets resulted in tensile failure, which allows the derivation of the tensile strength of the tablets and also ensures that the failure mechanism was consistent. Differences in the magnitude of the value of the tensile strength by the different testing systems appear to be a consequence of contact areas provided by the different platens. Using the semi-circular platen system, for a given material, the values of the tensile strength of the tablets, prepared at the same pressure, for a given material were found to be the same for circular, square and hexagonal shaped tablets.

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