From: The Department of Technology, the Royal Dental College, Copenhagen, Denmark.

# THE RELATIONSHIP BETWEEN THE RETENTION OF CEMENTED VENEER CROWNS AND THE CRUSHING STRENGTH OF THE CEMENTS

*by*

KNUD DREYER JØRGENSEN

KAREN HOLST

## INTRODUCTION

Theoretical consideration of the mechanism of the cement binding leads to the conclusion that the compressibility and crushing strength for the materials involved in the cement binding are important factors in the retention. The object of the present work was to investigate the effect exerted by the crushing strength of the cement upon the retention of cemented veneer crowns.

An examination of the available literature has shown that no previous studies have been reported on the exact relationship between crushing strength and retention.

## METHODS

The cements used in the investigation are listed in Table I. Normal consistency of the phosphate cements was determined in accordance with Federation Dentaire Internationale Specification No. 6 for Dental Zinc Phosphate Cements. The other cements were

Table I. *List of the cements used in present study*

| No. | Type | | Brand |
|---|---|---|---|
| 1 | Zinc Cement | Phosphate cement | Gebr. de Trey, A. G. Zürich |
| 2 | Pharmacent | Phosphate cement | Pharmacia, Uppsala |
| 3 | Kalzinol | Zinc oxide-eugenol cement | The Amalgamated Dental Co. Ltd., London |
| 4 | Calestone | Dental stone | The Amalgamated Dental Co. Ltd., London |
| 5 | Bi-oxol | | Experimental material supplied by Halfdan Nielsen, dentist, Århus Dental College |

Table II. *Influence of crushing strength of phosphate cements on the retention of steel caps*

| Cement No. | Powder/ Liquid g/cc | Retention | | | Crushing strength | | |
|---|---|---|---|---|---|---|---|
| | | x kp | s kp | e kp | x kp/cm² | s kp/cm² | e kp/cm² |
| 1 | 1.20/0.5 | 215.4 | 26.07 | 8.25 | 1062.5 | 69.47 | 31.05 |
| 1 | 1.50/0.5 | 238.1 | 18.10 | 5.72 | 1276.9 | 103.95 | 46.48 |
| 1 | 1.80/0.5 | 248.2 | 19.29 | 6.10 | 1444.5 | 84.00 | 37.56 |
| 2 | 1.30/0.5 | 161.4 | 11.96 | 3.78 | 576.5 | 27.98 | 12.52 |
| 3 | 1.60/0.5 | 91.5 | 8.41 | 2.66 | 309.5 | 34.59 | 10.93 |
| 4 | 1.50/0.5 | 114.0 | 6.70 | 2.12 | 258.2 | 8.91 | 4.00 |
| 5 | 1.30/0.5 | 75.7 | 7.87 | 2.63 | 154.2 | 20.16 | 6.37 |

mixed to a consistency estimated to correspond, approximately, to normal consistency of the phosphate cements. In addition to normal consistency, de Trey's zinc cement was mixed to a thicker and a thinner consistency.

The crushing strength of the cements was determined in the following way: A cylindrical mold, 6 mm in diameter by 12 mm high, was placed on a glass plate and slightly overfilled with freshly mixed cement. Another glass plate was then forced down on the mold so that the cement excess was squeezed out. Two minutes after starting spatulation the mold with the two plates held together by means of a C-clamp was transferred to a container with 100 % relative humidity at 37° C. One hour later the test specimen was withdrawn from the cylinder and immersed in distilled water at 37° C. Twenty-four hours ± one hour after

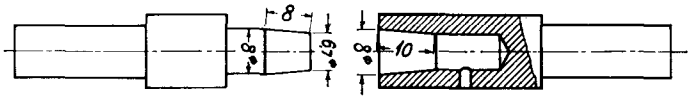


Fig. 1. Truncated cone and cap used in the retention tests.

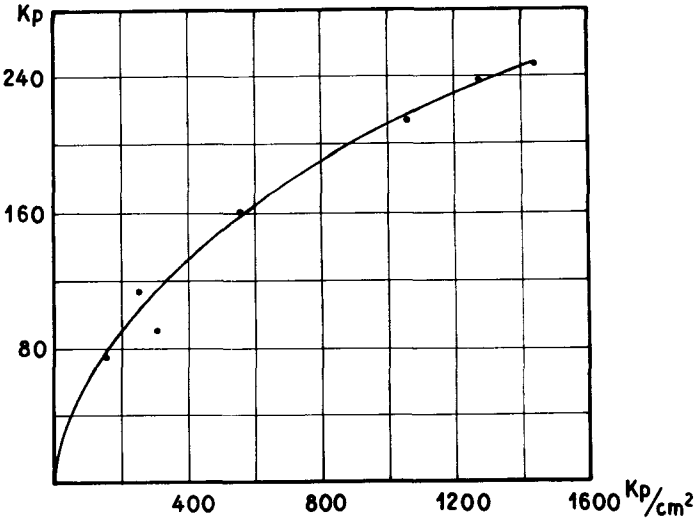


Fig. 2. Retention plotted against crushing strength of the cement.

preparation the specimen was crushed in a Losenhausen testing machine loaded at the rate of 2 kp/sec. The specimen was kept wet during crushing. The crushing strength for each cement was computed as the average of 5 tests, for cement No. 3 and 5, however, of 10 tests.

The retention tests were conducted with truncated cones and caps of stainless steel (Figure 1). The cones had the following dimensions: Base diameter 8 mm, height 8 mm, upper diameter 6.7 mm, taper angle 9.3°. The cones were prepared in a lathe, and to make their surfaces as uniform as possible they were all turned at the same rate with the same tool. The caps were likewise prepared by uniform technique. In continuation of the conical cavity in the caps a cylindrical hole was bored, from which there was an outlet through a canal. Both cones and caps were shaped to permit mounting in the tensile testing machine.

A standardized technique was also used in spatulation of the

cement and cementation of cones and caps. Cementation was carried out 2 minutes after starting the mix, and the cementation pressure, 4 kp, was maintained for 10 minutes. Thirty minutes after cementation the cone with the cap cemented in place was stored in distilled water at 37° C. Twenty-four hours ± one hour after cementation cone with cap was mounted in a Losenhausen tensile tester and pulled apart at the rate of 2 kp/sec. Ten retention tests were made with each cement. Each cone and cap was only used for one test.

## RESULTS

The experimental results are recorded in Table II and illustrated by the curve in Figure 2. The table shows the mean values with standard deviation and standard error for each test group. It is seen that the retention obtained by the cementation varies directly with the chrushing strength. Experiments made with de Trey's zinc cement in three different powder/liquid ratios show that both crushing strength and retention are increased with the amount of powder added to the liquid.

## SUMMARY

The present work was a study on the relationship between the retention of cemented veneer crowns and the crushing strength of the cements used. The results were presented in Table II and in Figure 2. By increasing the crushing strength of the cements there was an almost proportional increase in retention.

## RÉSUMÉ

### RAPPORT ENTRE LA RÉTENTION DES COURONNES DE REVÊTEMENT COULÉES, APRÈS SCELLEMENT, ET LA RÉSISTANCE A L'ÉCRASEMENT DES CIMENTS EMPLOYÉS

Les auteurs ont effectué une étude sur l'influence que peut avoir sur la rétention des couronnes de revêtement coulées, après scellement, la résistance à l'écrasement du ciment employé. Les tests de rétention ont été faits en utilisant des moignons et des coiffes d'acier inoxydable qui ont été scellées au moyen de différents ciments. Un rapport positif a ainsi été mis en évidence entre la résistance à l'écrasement du ciment et la rétention.

ZUSAMMENFASSUNG

DAS VERHÄLTNIS ZWISCHEN DER RETENTION ZEMENTIERTER FURNIERKRONEN UND DER BRUCHFESTIGKEIT DES ZEMENTS

Es ist untersucht worden, welchen Einfluss die Bruchfestigkeit des Zements auf die Retention in zementierten Furnierkronen hat. Für die Retentionsversuche wurden Stümpfe und Kappen aus rostfreiem Stahl verwendet, die mit verschiedenen Zementen zementiert wurden. Durch die Versuche wurde ein positives Verhältnis zwischen der Bruchfestigkeit des Zements und der Retention gefunden.

Address: *Department of Technology,*
*Royal Dental College,*
*Jagtvej 160, Copenhagen Ø,*
*Denmark*