Apparent Modulus of Elasticity of Dental Amalgams

J. M. POWERS and J. W. FARAH

University of Michigan, School of Dentistry, Ann Arbor, Michigan 48104, USA

The modulus of elasticity of dental amalgam has been determined by analysis of creep data (OGLESBY ET AL, *J Res Natl Bur Stan* 72C: 203, 1968) and by ultrasonic methods (DICKSON and OGLESBY, *J Dent Res* 46: 1475, 1967; HALL ET AL, *J Dent Res* 52: 390, 1973) to be between 63,000 and 70,000 MN/m². These values represent the instantaneous elastic compliance term when dental amalgam is treated as a viscoelastic material. It is convenient, however, to approximate the behavior of dental amalgam as elastic in experimental stress analysis models. Thus, an apparent modulus of elasticity *(E')* can be determined by measurement of the slope of a stress-strain curve in compression at a given loading rate. Values of *E'* determined in this manner for conventional dental amalgams at the one-week period were from 9,660 to 12,400 MN/m² within a stress range from 34.5 to 172 MN/m² at a loading rate of 0.008 cm/min (TAYLOR ET AL, *J Dent Res* 28: 228, 1949).

Values of *E'* and compressive strength *(S)* were determined for five dental amalgams at 24-hour and one-month periods. Cylindrical specimens were prepared, using the procedure described in American Dental Association Specification no. 1 *(Guide to Dental Materials and Devices,* 1975), from about 600 mg of amalgam alloy following the manufacturers' recommended mercury-alloy ratios and trituration conditions. Specimens were loaded in compression to failure on a testing machine[a] at a head speed of 0.020 cm/min. Deflection data were obtained from an optical strain gauge[b] with the smallest measurable deflection being 1.03 micrometers. *E'* was computed from the slope of the linear portion of a load-deflection curve with a correction made for the deflection of the steel plungers included within the gauge length.

Average values of *E'* and *S* measured at 24-hour and one-month periods are shown in the table. Scheffe intervals computed for the 95% level from analysis of variance were 5 and 1,800 MN/m² for horizontal comparisons of *S* and *E'*, respectively, and 13 and 4,600 MN/m² for vertical comparisons of *S* and *E'*, respectively. For each amalgam except *C*, values of *E'* and *S* were higher at the one-month period than at 24 hours. The amalgams containing copper as a major ingredient (*D* and *E*) had higher values of *E'* and *S* at both times tested than the amalgams made from conventional *(A)* and spherical (*B* and *C*) silver-tin alloys.

[a] Reihle, Wilson Instrument Division, Bridgeport, Conn.

[b] Tuckerman, American Instrument Co., Inc., Silver Spring, Md.

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TABLE

APPARENT MODULUS AND COMPRESSIVE STRENGTH OF DENTAL AMALGAMS

Material	24-Hr* Compressive Strength	24-Hr* Modulus	1 Mo* Compressive Strength	1 Mo* Modulus
A†	318 (9)	21,100 (1,400)	346 (13)	24,100 (3,700)
B‡	344 (6)	18,900 (940)	409 (2)	23,000 (1,200)
C§	367 (7)	24,100 (3,900)	382 (12)	24,600 (2,500)
D¶	423 (14)	34,000 (5,100)	481 (8)	36,300 (7,100)
E#	483 (13)	31,300 (3,400)	569 (5)	35,600 (4,000)

* Units are MN/m². Means with standard deviations in parentheses were determined from five to eight replications.

† New True Dentalloy (capsules), Lot No. 037403, S. S. White, Philadelphia, Pa.

‡ Spher-a-Caps, Lot No. 1928, Kerr Sybron Corp., Romulus, Mich.

§ Spherical Alloy Caps, Lot No. 12A72, L. D. Caulk Co., Milford, Del.

¶ Dispersalloy (tablets), Lot No. 4A001, Johnson & Johnson, East Windsor, NJ.

Experimental alloy (powder), Lot No. R74831, Federal Mogul Corp., Ann Arbor, Mich; spherical particles with mean composition of Ag, 60%; Sn, 27%; and Cu, 13%.