

## รายการอ้างอิง

- Anusavice JK. Phillips' Science Dental Materials. St Louis: Elsevier Science, 2003.
- Aydin C, Yilmaz H, Caglar A. Effect of glass fiber reinforcement on the flexural strength of denture base resin. Quintessence Int 2002;33:457-463.
- Behr M, Rosentritt M, Lang R, Handel G. Flexural properties of fiber reinforced composite using a vacuum/pressure or a manual adaptation manufacturing process. J Dent 2000;28:509-514.
- Bowen RL. Use of epoxy-resin in restorative materials. J Dent Res. 1956;35:361-369.
- Cal EN, Hersek N, Sahin E. Water sorption and dimensional changes of denture base polymer reinforced with glass fibers in continuous unidirectional and woven form. Int J Prosthodont 2000;13:487-493.
- Chai J, Takahashi Y, Hisama K, Shimizu H. Water sorption and dimensional stability of three glass fiber reinforced composites. Int J Prosthodont 2004;17:195-199.
- Chang CT. Plasma surface treatment in composites manufacturing. Journal of Industrial Technology 1999;15:1-7.
- Chung K, Lin T, Wang F. Flexural strength of a provisional resin material with fiber addition. J Oral Rehabil 1998;25:214-217.
- Chow TW, Cheng YY, Ladizesky NH. Polyethylene fiber reinforced polymethyl methacrylate-Water sorption and dimensional changes during immersion. J Dent 1993;21:367-372.
- Dhuru BV. Contemporary Dental Material. New Delhi: Oxford, 2004.
- Drummond JL, Bapna MS. Static and cyclic loading of fiber-reinforced dental resin. Dent Mater 2003;19:226-31.
- Dyer SR, Lassila LVJ, Jokinen M, Vallittu PK. Effect of fiber position and orientation on fracture load of fiber-reinforced composite. Dent Material 2004;20:947-955.
- El-Ebashi MK, Craig RG, Peyton FA. Experimental stress analysis of dental restorations, VII: structural design and stress analysis of fixed partial dentures. J Prosthet Dent 1970;23:177-183.

- Ellakwa AE, Shortall AC, Marquis PM. Influence of fiber type and wetting agent on the flexural properties of an indirect fiber reinforced composite. J Prosthet Dent 2002;88:485-490.
- Freilich MA, Meiers JC, Duncan JP, Goldberg AJ. Fiber-reinforced composites in clinical dentistry. Illinois: Quintessence Int ,2000.
- Goldberg AJ, Burstone CJ, Hadjinikolaou I, Jancar J. Screening of matrices and fibers for reinforced thermoplastics intended for dental applications. J Biomed Mater Res 1994;28:167-173.
- Grant AA, Greener EH. Whisker reinforcement of polymethyl methacrylate denture base resins. Aus Dent J 1976;12:29.
- Grandini S, Goracci C, Monticelli F, Tay FR, Ferrari M. Fatigue resistance and structural characteristics of fiber posts: three-point bending test and SEM evaluation. Dent Mater 2005;21:75-82.
- Hamza TA, Rosential SF, Elhosary MM, IbraheemRM. The effect of fiber reinforcement on the fracture toughness and flexural strength of provisional restorative resins. J Prosthet Dent 2004;91:258-264.
- Inanaga A, Naka S, Takahashi Y, Tchii D, Yoshinaga M, Miyazaki K. Studies on denture base resins reinforced carbon or aramid fiber. Part I. The effectiveness of fiber and surface treatments J Jpn Prosthodont Soc 1993;37:1083-1090.
- Kanie T, Fujii K, Arikawa H, Inoue K. Flexural properties and impact strength of denture base polymer reinforced with woven glass fibers. Dent Mater 2000;16:150-158.
- Kanie T, Arikawa H, Fujii K, Ban S. Light – curing reinforcement for denture base resin using a glass fiber cloth pre-impregnated with various urethane oligomers. Dent Mater J 2004;23:291-296.
- Kato H, Matsumura H, Tanaka T, Atsuta M. Bond strength and durability of porcelain bonding systems. J Prosthet Dent 2003;31:521-525.
- Kilfoil BM, Hesby RA, Pelleu GB Jr. The tensile strength of a composite resin reinforced with carbon fibers. J Prosthet Dent 1983;50:40-43.

- Kosoric J, Cattani M, Bouillaguet S, Godin Ch, Meyer JM. Reinforcement of composite resins with unidirectional glass fibers. European Cells and Materials 2002;3:24-25.
- Kolbeck C, Rosentritt M, Behr M, Lang R, Handel G. In vitro study of fracture strength and marginal adaptation of polyethylene-fiber-reinforced-composite versus glass-fibre-reinforced-composite fixed partial dentures. J Oral Rehabil 2002;29:668-674.
- Ladizesky NH, Chow TW, Cheng YY. Denture base reinforcement using woven polyethylene fiber. Int J Prosthodont 1994;7:307-314.
- Lassila LVJ, Tanner J, Anna-Maria Le Bell, Narva K, Vallittu PK. Flexural properties of fiber reinforced root canal posts. Dent Mater 2004;20:29-36.
- Lassila LVJ, Nohrstrom T, Vallittu PK. The influence of short-term water storage on the flexural properties of unidirectional glass fiber-reinforced composite. Biomaterials 2002;23:2221-2229.
- Lassila LVJ, Vallittu PK. The effect of fiber position and polymerization condition on the flexural properties of fiber-reinforced composite. J Contemp Dent Pract 2004;15:1-12.
- Mannocci F, Sherriff M, Watson F, Vallittu PK. Penetration of bonding resins into fibre-reinforced composite posts: a confocal microscopic study. Inter Endo J 2005;38:46-51.
- Matinlinna JP, Lassila LVJ, Ozcan M, Yli-Urpo A, Vallittu PK. An Introduction to silanes and their clinical applications in dentistry. Int J Prosthodont. 2004;17(2):155-64.
- Miettinen VM, Vallittu PK. Water sorption and solubility of glass fiber-reinforced denture polymethyl methacrylate resin. J Prosthet Dent 1996;76:531-534.
- Nohara LB, Filho GP, Nohara EL, Kleinke MU, Rezende MC. Evaluation of carbon fiber surface treated by chemical and cold plasma processes. Mat Res 2005;8:1-15.
- Noort RV. Introduction to dental materials. London: Mosby, 2002.
- Pest LB, Cavalli G, Bertani P, Gagliani M. Adhesive post-endodontic restorations with fiber posts : push-out tests and SEM observations. Dent Mater 2002;18:596 -602.

- Plueddemann EP. Silane coupling agents. New York: Plenum;1991.
- Samadzadeh A, Kugel G, Hurley E, Aboushala A. Fracture strengths of provisional restorations reinforced with plasma-treated woven polyethylene fiber. J Prosthet Dent 1997;78:447-450.
- Shimozato T, Yamanaka A, Kurata S, Yamazaki N. Denture base PMMA resins reinforced with carbon fibers. Part I. Surface treatments of the carbon fibers and its effect on flexural and tensile strength of the reinforced resins. J Jpn Soc Dent Mater Device 1984;3:648-654.
- Solnit SG. The effect of methylmethacrylate reinforcement with silane-treated and untreated glass fibers. J Prosthet Dent 1991;66:310-314.
- Takahashi Y, Chai J, Kawaguchi M. Effect of water sorption on the Resistance to plastic deformation of a denture base material relined with four different denture relining materials. Int J Prosthodont 1998;11:49-54.
- Tezvergil A, Lassila LVJ, Yli-Urpo A, Vallittu PK. Repair bond strength of restorative resin composite applied to fiber-reinforced composite substrate. Acta Odontol Scand 2004;62:51-60.
- Vallittu PK. Comparison of two different silane compounds used for improving adhesion between fibers and acrylic denture base material. J Oral Rehabil 1993;20:533-539.
- Vallittu PK. The effect of void space and polymerization time on transverse strength of acrylic-glass fiber composite. J Oral Rehabil 1995;22:257-261.
- Vallittu PK. Some aspects of the tensile strength of unidirectional glass fibre-polymethyl methacrylate composite used in denture. J Oral Rehabil 1998;25:100-105.
- Vallittu PK, Ruyter IE, Ekstrand K. Effect of water storage on the flexural properties of E-glass and silica fiber acrylic resin composite. Int J Prosthodont 1998;11:340-350.
- Vallittu PK. Case report: a glass fiber reinforced composite resin bonded fixed partial denture. Eur J Prosthodont Restor Dent 2001;9:35-38.
- Vallittu PK. The Second International Symposium on Fiber-Reinforced Plastics in Dentistry. Turku: University of Turku;2002. p. 2-28.

Xu HHK, Schumacher GE, Eichmiller FC, Peterson RC, Antonucci JM, Mueller HJ.

Continuous-fiber perform reinforcement of dental resin composite restorations.

Dent Mater 2003;19:523-530.

ภาคผนวก

ตารางที่ 11 แสดงการวิเคราะห์การกระจายตัวของข้อมูล

One-Sample Kolmogorov-Smirnov Test

| group of samples       | TIME                   |                          | Fractural strength     |                    |
|------------------------|------------------------|--------------------------|------------------------|--------------------|
| no fiber               | 7                      | N                        | 10                     |                    |
|                        |                        | Normal Parameters(a,b)   | Mean<br>Std. Deviation | 31.1470<br>4.09325 |
|                        |                        | Most Extreme Differences | Absolute               | .142               |
|                        |                        |                          | Positive               | .129               |
|                        |                        |                          | Negative               | -.142              |
|                        |                        | Kolmogorov-Smirnov Z     | .450                   |                    |
|                        | Asymp. Sig. (2-tailed) | .987                     |                        |                    |
|                        | 30                     | N                        | 10                     |                    |
|                        |                        | Normal Parameters(a,b)   | Mean<br>Std. Deviation | 27.4420<br>4.66455 |
|                        |                        | Most Extreme Differences | Absolute               | .288               |
|                        |                        |                          | Positive               | .171               |
|                        |                        |                          | Negative               | -.288              |
| Kolmogorov-Smirnov Z   |                        | .912                     |                        |                    |
| Asymp. Sig. (2-tailed) | .376                   |                          |                        |                    |
| ribbon                 | 7                      | N                        | 10                     |                    |
|                        |                        | Normal Parameters(a,b)   | Mean<br>Std. Deviation | 36.9560<br>3.33690 |
|                        |                        | Most Extreme Differences | Absolute               | .283               |
|                        |                        |                          | Positive               | .283               |
|                        |                        |                          | Negative               | -.242              |
|                        |                        | Kolmogorov-Smirnov Z     | .895                   |                    |
|                        | Asymp. Sig. (2-tailed) | .400                     |                        |                    |
|                        | 30                     | N                        | 10                     |                    |
|                        |                        | Normal Parameters(a,b)   | Mean<br>Std. Deviation | 34.8920<br>3.19542 |
|                        |                        | Most Extreme Differences | Absolute               | .198               |
|                        |                        |                          | Positive               | .198               |
|                        |                        |                          | Negative               | -.150              |
| Kolmogorov-Smirnov Z   |                        | .625                     |                        |                    |
| Asymp. Sig. (2-tailed) | .830                   |                          |                        |                    |
| G-Interlig             | 7                      | N                        | 10                     |                    |
|                        |                        | Normal Parameters(a,b)   | Mean<br>Std. Deviation | 43.2710<br>4.74067 |
|                        |                        | Most Extreme Differences | Absolute               | .260               |
|                        |                        |                          | Positive               | .260               |
|                        |                        |                          | Negative               | -.223              |
|                        |                        | Kolmogorov-Smirnov Z     | .822                   |                    |
| Asymp. Sig. (2-tailed) | .508                   |                          |                        |                    |
| 30                     | N                      | 10                       |                        |                    |

|                        |   |                          |                |                          |                |         |
|------------------------|---|--------------------------|----------------|--------------------------|----------------|---------|
| glass 10%              | 7 | Normal Parameters(a,b)   | Mean           | 36.3660                  |                |         |
|                        |   |                          | Std. Deviation | 5.14609                  |                |         |
|                        |   | Most Extreme Differences | Absolute       | .200                     |                |         |
|                        |   |                          | Positive       | .200                     |                |         |
|                        |   |                          | Negative       | -.193                    |                |         |
|                        |   | Kolmogorov-Smirnov Z     |                | .631                     |                |         |
|                        |   | Asymp. Sig. (2-tailed)   |                | .820                     |                |         |
|                        |   | N                        |                | 10                       |                |         |
|                        |   | glass 20%                | 30             | Normal Parameters(a,b)   | Mean           | 37.8050 |
|                        |   |                          |                |                          | Std. Deviation | 1.16537 |
|                        |   |                          |                | Most Extreme Differences | Absolute       | .163    |
|                        |   |                          |                |                          | Positive       | .163    |
|                        |   |                          |                |                          | Negative       | -.102   |
| Kolmogorov-Smirnov Z   |   |                          |                | .516                     |                |         |
| Asymp. Sig. (2-tailed) |   |                          |                | .953                     |                |         |
| N                      |   |                          |                | 10                       |                |         |
| glass 30%              | 7 |                          |                | Normal Parameters(a,b)   | Mean           | 35.0350 |
|                        |   |                          |                |                          | Std. Deviation | .88956  |
|                        |   |                          |                | Most Extreme Differences | Absolute       | .162    |
|                        |   |                          |                |                          | Positive       | .162    |
|                        |   |                          |                |                          | Negative       | -.111   |
|                        |   | Kolmogorov-Smirnov Z     |                | .513                     |                |         |
|                        |   | Asymp. Sig. (2-tailed)   |                | .955                     |                |         |
|                        |   | N                        |                | 10                       |                |         |
|                        |   | glass 20%                | 30             | Normal Parameters(a,b)   | Mean           | 54.9490 |
|                        |   |                          |                |                          | Std. Deviation | 6.24091 |
|                        |   |                          |                | Most Extreme Differences | Absolute       | .156    |
|                        |   |                          |                |                          | Positive       | .100    |
|                        |   |                          |                |                          | Negative       | -.156   |
| Kolmogorov-Smirnov Z   |   |                          |                | .494                     |                |         |
| Asymp. Sig. (2-tailed) |   |                          |                | .968                     |                |         |
| N                      |   |                          |                | 10                       |                |         |
| glass 30%              | 7 |                          |                | Normal Parameters(a,b)   | Mean           | 47.1210 |
|                        |   |                          |                |                          | Std. Deviation | 9.43233 |
|                        |   |                          |                | Most Extreme Differences | Absolute       | .195    |
|                        |   |                          |                |                          | Positive       | .166    |
|                        |   |                          |                |                          | Negative       | -.195   |
|                        |   | Kolmogorov-Smirnov Z     |                | .615                     |                |         |
|                        |   | Asymp. Sig. (2-tailed)   |                | .844                     |                |         |
|                        |   | N                        |                | 10                       |                |         |
|                        |   | glass 10%                | 7              | Normal Parameters(a,b)   | Mean           | 79.2440 |
|                        |   |                          |                |                          | Std. Deviation | 3.03717 |
|                        |   |                          |                | Most Extreme Differences | Absolute       | .181    |
|                        |   |                          |                |                          | Positive       | .181    |
|                        |   |                          |                |                          | Negative       | -.132   |
| Kolmogorov-Smirnov Z   |   |                          |                | .572                     |                |         |
| Asymp. Sig. (2-tailed) |   |                          |                | .899                     |                |         |



|           |    |                        |                |         |
|-----------|----|------------------------|----------------|---------|
|           | 30 | N                      |                | 10      |
|           |    | Normal                 | Mean           | 71.0780 |
|           |    | Parameters(a,b)        | Std. Deviation | 3.63444 |
|           |    | Most Extreme           | Absolute       | .173    |
|           |    | Differences            | Positive       | .161    |
|           |    |                        | Negative       | -.173   |
|           |    | Kolmogorov-Smirnov Z   |                | .547    |
|           |    | Asymp. Sig. (2-tailed) |                | .926    |
| glass 40% | 7  | N                      |                | 10      |
|           |    | Normal                 | Mean           | 67.0020 |
|           |    | Parameters(a,b)        | Std. Deviation | 9.45093 |
|           |    | Most Extreme           | Absolute       | .305    |
|           |    | Differences            | Positive       | .305    |
|           |    |                        | Negative       | -.137   |
|           |    | Kolmogorov-Smirnov Z   |                | .964    |
|           |    | Asymp. Sig. (2-tailed) |                | .311    |
|           | 30 | N                      |                | 10      |
|           |    | Normal                 | Mean           | 61.6860 |
|           |    | Parameters(a,b)        | Std. Deviation | 3.70958 |
|           |    | Most Extreme           | Absolute       | .405    |
|           |    | Differences            | Positive       | .236    |
|           |    |                        | Negative       | -.405   |
|           |    | Kolmogorov-Smirnov Z   |                | 1.280   |
|           |    | Asymp. Sig. (2-tailed) |                | .076    |

a Test distribution is Normal.  
 b Calculated from data.

ตารางที่ 12 แสดงการวิเคราะห์ความแปรปรวนแบบจำแนก 2 ทาง ของกลุ่มชิ้นงานชนิด  
ต่างๆกับระยะเวลาที่ทำการทดลอง

**Between-Subjects Factors**

|                        |   | Value Label | N  |
|------------------------|---|-------------|----|
| group<br>of<br>samples | 1 | no fiber    | 20 |
|                        | 2 | ribbon      | 20 |
|                        | 3 | G-Interfig  | 20 |
|                        | 4 | glass 10%   | 20 |
|                        | 5 | glass 20%   | 20 |
|                        | 6 | glass 30%   | 20 |
|                        | 7 | glass 40%   | 20 |
| TIME                   | 1 | 7           | 70 |
|                        | 2 | 30          | 70 |

**Tests of Between-Subjects Effects**

Dependent Variable: Fractural strength

| Source          | Type III Sum<br>of Squares | df  | Mean Square | F        | Sig. |
|-----------------|----------------------------|-----|-------------|----------|------|
| Corrected Model | 35318.344 <sup>a</sup>     | 13  | 2716.796    | 104.378  | .000 |
| Intercept       | 314920.023                 | 1   | 314920.023  | 12099.13 | .000 |
| GR              | 34170.544                  | 6   | 5695.091    | 218.804  | .000 |
| TIME            | 964.898                    | 1   | 964.898     | 37.071   | .000 |
| GR * TIME       | 182.903                    | 6   | 30.484      | 1.171    | .326 |
| Error           | 3279.567                   | 126 | 26.028      |          |      |
| Total           | 353517.934                 | 140 |             |          |      |
| Corrected Total | 38597.911                  | 139 |             |          |      |

a. R Squared = .915 (Adjusted R Squared = .906)

ตารางที่ 13 แสดงการวิเคราะห์แบบทีและความเป็นอิสระต่อกันเปรียบเทียบค่าความ  
แข็งแรงคัดขวางของกลุ่มชิ้นงาน

Group Statistics

| group of samples | TIME                 | N  | Mean    | Std. Deviation | Std. Error Mean |
|------------------|----------------------|----|---------|----------------|-----------------|
| no fiber         | Fractural strength 7 | 10 | 31.1470 | 4.09325        | 1.29440         |
|                  | 30                   | 10 | 27.4420 | 4.66455        | 1.47506         |
| ribbon           | Fractural strength 7 | 10 | 36.9560 | 3.33690        | 1.05522         |
|                  | 30                   | 10 | 34.8920 | 3.19542        | 1.01048         |
| G-Interlig       | Fractural strength 7 | 10 | 43.2710 | 4.74067        | 1.49913         |
|                  | 30                   | 10 | 36.3660 | 5.14609        | 1.62734         |
| glass 10%        | Fractural strength 7 | 10 | 37.8050 | 1.16537        | .36852          |
|                  | 30                   | 10 | 35.0350 | .88956         | .28130          |
| glass 20%        | Fractural strength 7 | 10 | 54.9490 | 6.24091        | 1.97355         |
|                  | 30                   | 10 | 47.1210 | 9.43233        | 2.98276         |
| glass 30%        | Fractural strength 7 | 10 | 79.2440 | 3.03717        | .96044          |
|                  | 30                   | 10 | 71.0780 | 3.63444        | 1.14931         |
| glass 40%        | Fractural strength 7 | 10 | 67.0020 | 9.45093        | 2.98865         |
|                  | 30                   | 10 | 61.6860 | 3.70958        | 1.17307         |

Independent Samples Test

| group of samples |                    |                             | Levene's Test for Equality of Variances |      | t-test for Equality of Means |        |                 |                 |                       |   |          |
|------------------|--------------------|-----------------------------|---|------|------------------------------|--------|-----------------|-----------------|-----------------------|---|----------|
|                  |                    |                             | F                                       | Sig. | t                            | df     | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |          |
|                  |                    |                             |   |      |                              |        |                 |                 |                       | Lower                                     | Upper    |
| no fiber         | Fractural strength | Equal variances assumed     | .076                                    | .786 | 1.888                        | 18     | .075            | 3.7050          | 1.96246               | -.41798                                   | 7.82798  |
|                  |                    | Equal variances not assumed |   |      | 1.888                        | 17.701 | .076            | 3.7050          | 1.96246               | -.42298                                   | 7.83298  |
| ribbon           | Fractural strength | Equal variances assumed     | .635                                    | .436 | 1.413                        | 18     | .175            | 2.0640          | 1.46101               | -1.00547                                  | 5.13347  |
|                  |                    | Equal variances not assumed |   |      | 1.413                        | 17.966 | .175            | 2.0640          | 1.46101               | -1.00589                                  | 5.13389  |
| G-Interlig       | Fractural strength | Equal variances assumed     | .042                                    | .840 | 3.121                        | 18     | .006            | 6.9050          | 2.21261               | 2.25649                                   | 11.55351 |
|                  |                    | Equal variances not assumed |   |      | 3.121                        | 17.880 | .006            | 6.9050          | 2.21261               | 2.25425                                   | 11.55575 |
| glass 10%        | Fractural strength | Equal variances assumed     | .418                                    | .526 | 5.975                        | 18     | .000            | 2.7700          | .46362                | 1.79598                                   | 3.74402  |
|                  |                    | Equal variances not assumed |   |      | 5.975                        | 16.830 | .000            | 2.7700          | .46362                | 1.79110                                   | 3.74890  |
| glass 20%        | Fractural strength | Equal variances assumed     | 2.372                                   | .141 | 2.189                        | 18     | .042            | 7.8280          | 3.57656               | -.31393                                   | 15.34207 |
|                  |                    | Equal variances not assumed |   |      | 2.189                        | 15.613 | .044            | 7.8280          | 3.57656               | -.23072                                   | 15.42528 |
| glass 30%        | Fractural strength | Equal variances assumed     | .127                                    | .725 | 5.452                        | 18     | .000            | 8.1660          | 1.49778               | 5.01927                                   | 11.31273 |
|                  |                    | Equal variances not assumed |   |      | 5.452                        | 17.449 | .000            | 8.1660          | 1.49778               | 5.01214                                   | 11.31986 |
| glass 40%        | Fractural strength | Equal variances assumed     | 8.317                                   | .010 | 1.656                        | 18     | .115            | 5.3160          | 3.21062               | -1.42927                                  | 12.06127 |
|                  |                    | Equal variances not assumed |   |      | 1.656                        | 11.709 | .124            | 5.3160          | 3.21062               | -1.69869                                  | 12.33069 |

ตารางที่ 14 แสดงการวิเคราะห์ความแปรปรวนแบบจำแนกทางเดียว ของกลุ่มชิ้นงาน

**ANOVA**

Fractural strength

| TIME |                | Sum of Squares | df | Mean Square | F       | Sig. |
|------|----------------|----------------|----|-------------|---------|------|
| 7    | Between Groups | 18883.31       | 6  | 3147.219    | 116.431 | .000 |
|      | Within Groups  | 1702.936       | 63 | 27.031      |         |      |
|      | Total          | 20586.25       | 69 |             |         |      |
| 30   | Between Groups | 15470.13       | 6  | 2578.356    | 103.028 | .000 |
|      | Within Groups  | 1576.631       | 63 | 25.026      |         |      |
|      | Total          | 17046.77       | 69 |             |         |      |

**Robust Tests of Equality of Means**

Fractural strength

| TIME |                | Statistic <sup>a</sup> | df1 | df2    | Sig. |
|------|----------------|------------------------|-----|--------|------|
| 7    | Brown-Forsythe | 116.431                | 6   | 30.712 | .000 |
| 30   | Brown-Forsythe | 103.028                | 6   | 28.894 | .000 |

a. Asymptotically F distributed.

ตารางที่ 15 ตารางการเปรียบเทียบเชิงซ้อนแบบอนเฟอโรโรนิกซ์ของกลุ่มชิ้นงานและเวลาที่ทำการทดลอง

Multiple Comparisons

Dependent Variable: Fractural strength  
Tamhane

| TIME      | (I) group of sample | (J) group of sample | Mean Difference (I-J) | Std. Error | Sig.     | 95% Confidence Interval |             |
|-----------|---------------------|---------------------|-----------------------|------------|----------|-------------------------|-------------|
|           |                     |                     |                       |            |          | Lower Bound             | Upper Bound |
| 7         | no fiber            | ribbon              | -5.8090               | 1.67002    | .057     | -11.7274                | .1094       |
|           |                     | G-Interlig          | -12.1240*             | 1.98062    | .000     | -19.1216                | -5.1264     |
|           |                     | glass 10%           | -6.6580*              | 1.34584    | .011     | -11.9964                | -1.3196     |
|           |                     | glass 20%           | -23.8020*             | 2.36016    | .000     | -32.3262                | -15.2778    |
|           |                     | glass 30%           | -48.0970*             | 1.61180    | .000     | -53.8488                | -42.3452    |
|           |                     | glass 40%           | -35.8550*             | 3.25691    | .000     | -48.2300                | -23.4800    |
|           | ribbon              | no fiber            | 5.8090                | 1.67002    | .057     | -.1094                  | 11.7274     |
|           |                     | G-Interlig          | -6.3150               | 1.83327    | .067     | -12.8885                | .2585       |
|           |                     | glass 10%           | -.8490                | 1.11772    | 1.000    | -5.2002                 | 3.5022      |
|           |                     | glass 20%           | -17.9930*             | 2.23794    | .000     | -26.2749                | -9.7111     |
|           |                     | glass 30%           | -42.2880*             | 1.42686    | .000     | -47.3192                | -37.2568    |
|           |                     | glass 40%           | -30.0460*             | 3.16946    | .000     | -42.3706                | -17.7214    |
|           | G-Interlig          | no fiber            | 12.1240*              | 1.98062    | .000     | 5.1264                  | 19.1216     |
|           |                     | ribbon              | 6.3150                | 1.83327    | .067     | -.2585                  | 12.8885     |
|           |                     | glass 10%           | 5.4660                | 1.54376    | .105     | -.7235                  | 11.6555     |
|           |                     | glass 20%           | -11.6780*             | 2.47837    | .004     | -20.5052                | -2.8508     |
|           |                     | glass 30%           | -35.9730*             | 1.78040    | .000     | -42.4199                | -29.5261    |
|           |                     | glass 40%           | -23.7310*             | 3.34356    | .000     | -36.2048                | -11.2572    |
|           | glass 10%           | no fiber            | 6.6580*               | 1.34584    | .011     | 1.3196                  | 11.9964     |
|           |                     | ribbon              | .8490                 | 1.11772    | 1.000    | -3.5022                 | 5.2002      |
|           |                     | G-Interlig          | -5.4660               | 1.54376    | .105     | -11.6555                | .7235       |
|           |                     | glass 20%           | -17.1440*             | 2.00766    | .000     | -25.3123                | -8.9757     |
|           |                     | glass 30%           | -41.4390*             | 1.02871    | .000     | -45.4035                | -37.4745    |
|           |                     | glass 40%           | -29.1970*             | 3.01128    | .000     | -41.6016                | -16.7924    |
|           | glass 20%           | no fiber            | 23.8020*              | 2.36016    | .000     | 15.2778                 | 32.3262     |
|           |                     | ribbon              | 17.9930*              | 2.23794    | .000     | 9.7111                  | 26.2749     |
|           |                     | G-Interlig          | 11.6780*              | 2.47837    | .004     | 2.8508                  | 20.5052     |
|           |                     | glass 10%           | 17.1440*              | 2.00766    | .000     | 8.9757                  | 25.3123     |
| glass 30% |                     | -24.2950*           | 2.19484               | .000       | -32.5147 | -16.0753                |             |
| glass 40% |                     | -12.0530            | 3.58147               | .082       | -24.9787 | .8727                   |             |
| glass 30% | no fiber            | 48.0970*            | 1.61180               | .000       | 42.3452  | 53.8488                 |             |
|           | ribbon              | 42.2880*            | 1.42686               | .000       | 37.2568  | 47.3192                 |             |
|           | G-Interlig          | 35.9730*            | 1.78040               | .000       | 29.5261  | 42.4199                 |             |
|           | glass 10%           | 41.4390*            | 1.02871               | .000       | 37.4745  | 45.4035                 |             |
|           | glass 20%           | 24.2950*            | 2.19484               | .000       | 16.0753  | 32.5147                 |             |
|           | glass 40%           | 12.2420             | 3.13918               | .052       | -.0789   | 24.5629                 |             |
| glass 40% | no fiber            | 35.8550*            | 3.25691               | .000       | 23.4800  | 48.2300                 |             |
|           | ribbon              | 30.0460*            | 3.16946               | .000       | 17.7214  | 42.3706                 |             |
|           | G-Interlig          | 23.7310*            | 3.34356               | .000       | 11.2572  | 36.2048                 |             |
|           | glass 10%           | 29.1970*            | 3.01128               | .000       | 16.7924  | 41.6016                 |             |
|           | glass 20%           | 12.0530             | 3.58147               | .082       | -.8727   | 24.9787                 |             |
|           | glass 30%           | -12.2420            | 3.13918               | .052       | -24.5629 | .0789                   |             |

|           |            |            |           |         |          |          |          |
|-----------|------------|------------|-----------|---------|----------|----------|----------|
| 30        | no fiber   | ribbon     | -7.4500*  | 1.78798 | .015     | -13.8783 | -1.0217  |
|           |            | G-Interlig | -8.9240*  | 2.19637 | .015     | -16.6695 | -1.1785  |
|           |            | glass 10%  | -7.5930*  | 1.50164 | .012     | -13.6970 | -1.4890  |
|           |            | glass 20%  | -19.6790* | 3.32756 | .001     | -32.1154 | -7.2426  |
|           |            | glass 30%  | -43.6360* | 1.86995 | .000     | -50.2832 | -36.9888 |
|           |            | glass 40%  | -34.2440* | 1.88465 | .000     | -40.9338 | -27.5542 |
|           | ribbon     | no fiber   | 7.4500*   | 1.78798 | .015     | 1.0217   | 13.8783  |
|           |            | G-Interlig | -1.4740   | 1.91554 | 1.000    | -8.4349  | 5.4869   |
|           |            | glass 10%  | -.1430    | 1.04890 | 1.000    | -4.3110  | 4.0250   |
|           |            | glass 20%  | -12.2290  | 3.14928 | .052     | -24.5267 | .0687    |
|           |            | glass 30%  | -36.1860* | 1.53035 | .000     | -41.5886 | -30.7834 |
|           |            | glass 40%  | -26.7940* | 1.54828 | .000     | -32.2647 | -21.3233 |
|           | G-Interlig | no fiber   | 8.9240*   | 2.19637 | .015     | 1.1785   | 16.6695  |
|           |            | ribbon     | 1.4740    | 1.91554 | 1.000    | -5.4869  | 8.4349   |
|           |            | glass 10%  | 1.3310    | 1.65147 | 1.000    | -5.4086  | 8.0706   |
|           |            | glass 20%  | -10.7550  | 3.39781 | .136     | -23.2974 | 1.7874   |
|           |            | glass 30%  | -34.7120* | 1.99227 | .000     | -41.8533 | -27.5707 |
|           |            | glass 40%  | -25.3200* | 2.00607 | .000     | -32.4971 | -18.1429 |
|           | glass 10%  | no fiber   | 7.5930*   | 1.50164 | .012     | 1.4890   | 13.6970  |
|           |            | ribbon     | .1430     | 1.04890 | 1.000    | -4.0250  | 4.3110   |
|           |            | G-Interlig | -1.3310   | 1.65147 | 1.000    | -8.0706  | 5.4086   |
|           |            | glass 20%  | -12.0860  | 2.99600 | .058     | -24.4798 | .3078    |
|           |            | glass 30%  | -36.0430* | 1.18323 | .000     | -40.7884 | -31.2976 |
|           |            | glass 40%  | -26.6510* | 1.20633 | .000     | -31.4954 | -21.8066 |
|           | glass 20%  | no fiber   | 19.6790*  | 3.32756 | .001     | 7.2426   | 32.1154  |
|           |            | ribbon     | 12.2290   | 3.14928 | .052     | -.0687   | 24.5267  |
|           |            | G-Interlig | 10.7550   | 3.39781 | .136     | -1.7874  | 23.2974  |
|           |            | glass 10%  | 12.0860   | 2.99600 | .058     | -.3078   | 24.4798  |
| glass 30% |            | -23.9570*  | 3.19653   | .000    | -36.2700 | -11.6440 |          |
| glass 40% |            | -14.5650*  | 3.20515   | .015    | -26.8826 | -2.2474  |          |
| glass 30% | no fiber   | 43.6360*   | 1.86995   | .000    | 36.9888  | 50.2832  |          |
|           | ribbon     | 36.1860*   | 1.53035   | .000    | 30.7834  | 41.5886  |          |
|           | G-Interlig | 34.7120*   | 1.99227   | .000    | 27.5707  | 41.8533  |          |
|           | glass 10%  | 36.0430*   | 1.18323   | .000    | 31.2976  | 40.7884  |          |
|           | glass 20%  | 23.9570*   | 3.19653   | .000    | 11.6440  | 36.2700  |          |
|           | glass 40%  | 9.3920*    | 1.64226   | .000    | 3.6090   | 15.1750  |          |
| glass 40% | no fiber   | 34.2440*   | 1.88465   | .000    | 27.5542  | 40.9338  |          |
|           | ribbon     | 26.7940*   | 1.54828   | .000    | 21.3233  | 32.2647  |          |
|           | G-Interlig | 25.3200*   | 2.00607   | .000    | 18.1429  | 32.4971  |          |
|           | glass 10%  | 26.6510*   | 1.20633   | .000    | 21.8066  | 31.4954  |          |
|           | glass 20%  | 14.5650*   | 3.20515   | .015    | 2.2474   | 26.8826  |          |
|           | glass 30%  | -9.3920*   | 1.64226   | .000    | -15.1750 | -3.6090  |          |

\*. The mean difference is significant at the .05 level.

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่ไม่เสริมเส้นใย แขน้ำก้นที่อุณหภูมิ 37 องศาเซลเซียส  
เป็นเวลา 7 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 30.85      |
| 2       | 30.81      |
| 3       | 29.77      |
| 4       | 33.81      |
| 5       | 36.30      |
| 6       | 34.30      |
| 7       | 29.16      |
| 8       | 25.65      |
| 9       | 36.32      |
| 10      | 24.50      |
| Mean    | 31.147     |
| S.D.    | 4.09325    |
| Minimum | 24.50      |
| Maximum | 36.32      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่ไม่เสริมเส้นใย แขน้ำก้นที่อุณหภูมิ 37 องศาเซลเซียส  
เป็นเวลา 30 วัน

|         | Load (Mpa) |
|---------|------------|
| Maximum | 26.80      |
| 2       | 28.67      |
| 3       | 26.12      |
| 4       | 31.54      |
| 5       | 27.35      |
| 6       | 31.87      |
| 7       | 30.14      |
| 8       | 27.24      |
| 9       | 15.40      |
| 10      | 29.29      |
| Mean    | 27.442     |
| S.D.    | 4.66455    |
| Minimum | 15.40      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยโพลีเอทิลีนสำเร็จรูป แขน้ำก้นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 7 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 37.78      |
| 2       | 37.85      |
| 3       | 36.99      |
| 4       | 36.74      |
| 5       | 30.40      |
| 6       | 37.95      |
| 7       | 36.47      |
| 8       | 34.07      |
| 9       | 37.59      |
| 10      | 43.72      |
| Mean    | 36.956     |
| S.D.    | 3.3369     |
| Minimum | 30.40      |
| Maximum | 43.72      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยโพลีเอทิลีนสำเร็จรูป แขน้ำก้นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 30 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 39.54      |
| 2       | 31.59      |
| 3       | 34.17      |
| 4       | 37.04      |
| 5       | 31.98      |
| 6       | 36.12      |
| 7       | 30.71      |
| 8       | 39.02      |
| 9       | 36.52      |
| 10      | 32.23      |
| Mean    | 34.892     |
| S.D.    | 3.19542    |
| Minimum | 30.71      |
| Maximum | 39.54      |



กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วสำเร็จรูปต่างประเทศ แขน้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 7 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 41.13      |
| 2       | 55.26      |
| 3       | 44.96      |
| 4       | 41.81      |
| 5       | 42.57      |
| 6       | 41.86      |
| 7       | 44.97      |
| 8       | 41.10      |
| 9       | 37.20      |
| 10      | 41.85      |
| Mean    | 43.271     |
| S.D.    | 4.74067    |
| Minimum | 37.20      |
| Maximum | 55.26      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วสำเร็จรูปต่างประเทศ แขน้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 30 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 29.67      |
| 2       | 37.59      |
| 3       | 35.86      |
| 4       | 47.53      |
| 5       | 39.07      |
| 6       | 35.53      |
| 7       | 29.06      |
| 8       | 34.97      |
| 9       | 36.09      |
| 10      | 38.29      |
| Mean    | 36.366     |
| S.D.    | 5.14609    |
| Minimum | 29.06      |
| Maximum | 47.53      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเทศปริมาณร้อยละ 10 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 7 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 36.23      |
| 2       | 40.00      |
| 3       | 38.39      |
| 4       | 36.83      |
| 5       | 37.38      |
| 6       | 36.79      |
| 7       | 37.99      |
| 8       | 37.51      |
| 9       | 37.62      |
| 10      | 39.31      |
| Mean    | 37.805     |
| S.D.    | 1.16537    |
| Minimum | 36.23      |
| Maximum | 40.00      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเทศปริมาณร้อยละ 10 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 30 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 35.57      |
| 2       | 35.06      |
| 3       | 34.27      |
| 4       | 33.71      |
| 5       | 36.14      |
| 6       | 35.46      |
| 7       | 36.39      |
| 8       | 35.22      |
| 9       | 34.13      |
| 10      | 34.40      |
| Mean    | 35.035     |
| S.D.    | 0.88956    |
| Minimum | 33.71      |
| Maximum | 36.39      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเภทปริมาณร้อยละ 20 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 7 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 49.73      |
| 2       | 59.28      |
| 3       | 62.93      |
| 4       | 62.05      |
| 5       | 54.52      |
| 6       | 44.61      |
| 7       | 55.47      |
| 8       | 53.13      |
| 9       | 60.11      |
| 10      | 47.66      |
| Mean    | 54.949     |
| S.D.    | 6.24091    |
| Minimum | 44.61      |
| Maximum | 62.93      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเภทปริมาณร้อยละ 20 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 30 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 37.36      |
| 2       | 59.83      |
| 3       | 35.19      |
| 4       | 41.59      |
| 5       | 58.92      |
| 6       | 40.10      |
| 7       | 46.44      |
| 8       | 43.08      |
| 9       | 59.88      |
| 10      | 48.82      |
| Mean    | 47.121     |
| S.D.    | 9.43233    |
| Minimum | 35.19      |
| Maximum | 59.88      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเทศปริมาณร้อยละ 30 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 7 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 74.45      |
| 2       | 77.59      |
| 3       | 81.29      |
| 4       | 79.39      |
| 5       | 83.78      |
| 6       | 78.79      |
| 7       | 76.38      |
| 8       | 77.79      |
| 9       | 79.05      |
| 10      | 83.93      |
| Mean    | 79.244     |
| S.D.    | 3.03717    |
| Minimum | 74.45      |
| Maximum | 83.93      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเทศปริมาณร้อยละ 30 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 30 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 70.52      |
| 2       | 76.19      |
| 3       | 76.73      |
| 4       | 69.90      |
| 5       | 64.23      |
| 6       | 72.02      |
| 7       | 70.21      |
| 8       | 72.48      |
| 9       | 68.27      |
| 10      | 70.23      |
| Mean    | 71.078     |
| S.D.    | 3.63444    |
| Minimum | 64.23      |
| Maximum | 76.73      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเภทปริมาณร้อยละ 40 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 7 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 78.08      |
| 2       | 62.61      |
| 3       | 64.49      |
| 4       | 58.28      |
| 5       | 61.85      |
| 6       | 86.37      |
| 7       | 74.10      |
| 8       | 63.52      |
| 9       | 64.04      |
| 10      | 56.68      |
| Mean    | 67.002     |
| S.D.    | 9.45093    |
| Minimum | 56.68      |
| Maximum | 86.37      |

กลุ่มชิ้นงาน เรซิน คอมโพสิต ที่เสริมเส้นใยแก้วในประเภทปริมาณร้อยละ 40 โดยปริมาตร แช่ใน  
น้ำกลั่นที่อุณหภูมิ 37 องศาเซลเซียสเป็นเวลา 30 วัน

|         | Load (Mpa) |
|---------|------------|
| 1       | 62.51      |
| 2       | 51.40      |
| 3       | 63.17      |
| 4       | 63.72      |
| 5       | 61.99      |
| 6       | 61.73      |
| 7       | 63.02      |
| 8       | 64.35      |
| 9       | 63.11      |
| 10      | 61.86      |
| Mean    | 61.686     |
| S.D.    | 3.70958    |
| Minimum | 51.40      |
| Maximum | 63.72      |

### ประวัติผู้เขียนวิทยานิพนธ์

นาย พิสมัยศิษฐ์ ชัยจรีนนท์ เกิดเมื่อวันที่ 21 กุมภาพันธ์ 2521 ที่จังหวัดกรุงเทพมหานคร สัญชาติไทย ด้านการศึกษา พ.ศ. 2538 จบมัธยมศึกษาตอนปลายจากโรงเรียนทวิธาภิเศก พ.ศ. 2545 จบปริญญาตรีทันตแพทยศาสตรบัณฑิตจากคณะทันตแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ ด้านกิจกรรม พ.ศ. 2542 ประธานชมรมเชียร์คณะทันตแพทยศาสตร์ เชียงใหม่ พ.ศ. 2543 นายก สโมสรนักศึกษา คณะทันตแพทยศาสตร์ เชียงใหม่ พ.ศ. 2545 ประธานกรรมการบัณฑิต มหาวิทยาลัยเชียงใหม่ ด้านการทำงาน พ.ศ. 2545-ปัจจุบัน พนักงานมหาวิทยาลัย ตำแหน่ง อาจารย์ ภาควิชาทันตกรรมประดิษฐ์ คณะทันตแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่