NEW STUDIES OF FIXED PARTIAL PROSTHESES ANALYSIS. BIDIMENSIONAL PHOTOELASTICITY APPROACH

Meda Negrutiu[1], Cosmin Sinescu[1], Radu Negru[2], Mihai Hluscu[2], Camelia Demian[2], Mihai Rominu[1]

REZUMAT

Fotoelasticitatea, ca metodă de investigaţie se bazează pe observaţia fundamentală potrivit căreia tensiunea în cazul unei forţe plane nu depinde de constanta de elasticitate a materialului. Privind ecuaţiile de stare bidimensionale, putem observa că în structură nu apare constant material. Pornind de la această observaţie, a fost elaborată o metodă experimentală de investigare. Cu această metodă se poate determina starea reală a tensiunilor la nivelul unui model alcătuit dintr-un material optic activ, care prezintă fenomene de birefringenţă.

Cuvinte cheie: fotoelasticitate, distribuţia tensiunilor, fenomene de birefringenţă

ABSTRACT

The photoelastic method is based on the fundamental observation that tension in case of a plane force does not depend by the material's constant elasticity. If we look at the equations of counterpoise at a plane level, we can observe that in the structure does not appear constant material. Starting with this observation, an experimental method of investigation was elaborated. With this method we can view the tension's real status, on a cast build from an optic active material that present the birefringence accidental phenomena.

Key Words: photoelasticity, tension's distribution, birefringence phenomena

INTRODUCTION

As a work method, photoelasticity is based on determining some optic effects which takes place at the pass of polarized light through mechanic birefringence environment.[1]

Isocline and Isocrome[2]

If the cast is not demanded and is viewed through the analyzer when its polarized plan is perpendicular on polarized horizontal plan of first grinder, the screen is not lighted (dark, turn off). In this situation, the cast is mechanically demanded and the tension varies - in general - from a point to another, and the cast's material optic properties are different in different points. In this case, viewing the cast through analyzer, dots and dark sheets alternating with light sheets appear on its surface.

If on a spot cast the normal tension difference is null, the birefringence does not appear, so the image on the screen of this spot will be dark. On the cast surface, a dark slice family called isocrome appears, which represent the geometric place of the dots in which the normal main tension difference is constant (and minimum). Using this slice family the main tension value in any dot from the surface cast can be determined. Furthermore, a family of dark slices called isocline appears on the cast surface representing the geometric place of dots in normal main tension direction; this is the same with polarization direction of the polarizator and stays perpendicular. Isocline families of different angle parameters are obtained; these are involved in determining the main tension direction from any dot of cast surface.

[1] Department of Prostheses Technology and Dental Materials, Faculty of Dental Medicine, Victor Babes University of Medicine and Pharmacy, Timisoara, [2] Department of Materials Strength, Faculty of Mechanics, Polytechnic University, Timisoara

Correspondence to:
Meda Negrutiu, 9 Revolutiei din 1989 Blvd., 300070 Timisoara, Tel. +40722700593
Email: meda_negrutiu@yahoo.com

Received for publication: Sep. 5, 2006. Revised: Dec. 23, 2006.

Using the polariscope with plane-polarized light on the cast surface shows these two families, the isocline and isocrome family, one above the other. Sometimes these are difficult to identify and in such cases white light takes monocrome light's place; now, isocrome family appear colored in white light.[3]

A DINOX 010P resin and triethylenetetramin as bracing and ROMPOXID as basic substance were used.[4]

MATERIALS AND METHODS

Two partial fix dentures were investigated (a classic one, with three elements and one with two extensions).[5] Each denture was reproduced for the study. Metal was used for reproducing the dentures. The goal of the study was to assess the tension relation between the bone thickness and denture material.

The probes were made by pouring optic active resin in duplicate moulds.[4] The resin was mixed in a disposable glass recipient.

The probes were loaded with calibrated drop press with a special device. For each quarter of rotation (90 degrees) an account on used device was obtained. For intermediary rotations, the number and final position were noted and reproduced on calibrated device; the force value was obtained.[2]

Realizing the probes and frizzing the tensions were made in an oven with a special system for monitoring the temperature. The manufacturer indications on thermal treatment were respected.[6]

A horizontal polariscope was used in this study, calibrated bypassing the light from the source through "closed" optic environment.[7]

Most research of photoelasticity are based on bidimensional plans, because their use is more facile.[2,4]

Patient's partial fix dentures were mould in metal a few years ago (Figs. 1a, 1b).

Figure 1. Partial fix dentures with teeth used in study.

The pattern was much thinner because the silicon should not relax during polymerization. (Fig. 2)

After "cold" mixing, without extra heat, in about two hours the probes were poured. The base and activator were mixed until the material got a fluid aspect.

The probes are introduced in the oven at 1200^0 C for losing the tensions. At this temperature the probes are loaded and left for 4-5 hours; after this stage the probes are getting cold slowly in the oven in 10-12 hours. (Figs. 3-6)

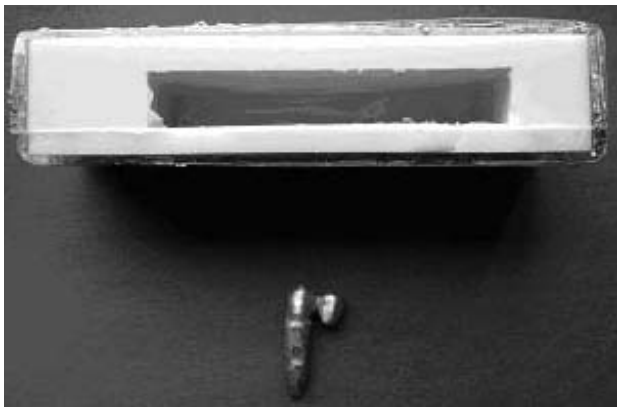

Figure 2. The pattern and metal denture with teeth.

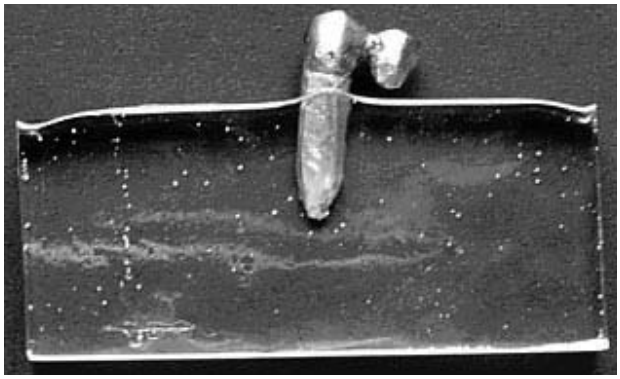

Figure 3. Probe number 3 after removing the pattern.

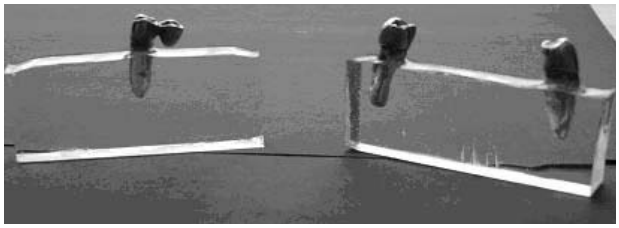

Figure 4. Transparent probe.

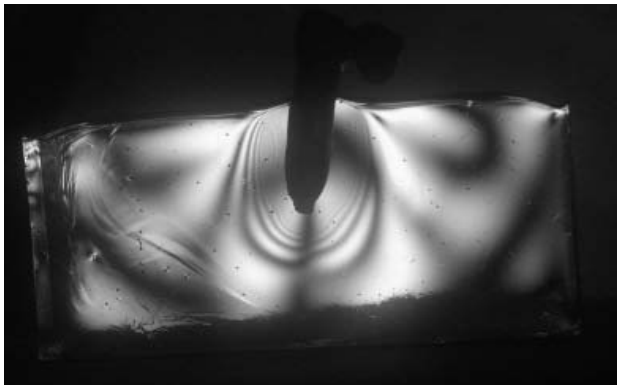

Figure 5. View of tensions at polariscope for probe 3 (optic zoom).

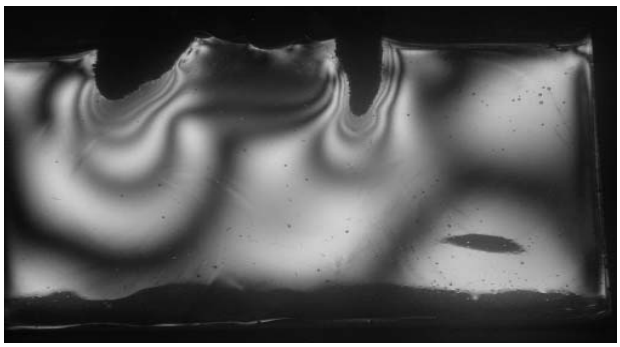

Figure 6. View of tensions at polariscope for probe 10 (optic zoom).

DISCUSSION

For probe 3 an external force (masticatory force) was considered. This force acts on the extension. Tensions can be observed at bone support. In time, the action of this force produces mobilization of the tooth.

For probe 10, which used natural support teeth, the tensions are loaded in molar area. If the natural support teeth are inclined the force dispersion is the same.

This bidimensional study of photoelasticity is easy to perform and bring precise information about the forces. The dates obtained with this method are compared with numerical methods.[8-11]

For its qualities, the method was used for tension evaluation of parodontal area of natural support teeth of partial fix dentures.

CONCLUSIONS

The tensions demonstrated in the support bone do not depend on denture's material. The pattern tension dissipation of natural probes is the same, in the same loading condition with the metal probes.

This is very important information for simplifying future studies of photoelasticity for much complex cases.

REFERENCES

1. Asundi A, Kishen A. Stress distribution in the dento-alveolar system using digital photoelasticity. Proc Inst Mech Eng 2000;214(6):659-67.
2. Fernandes CP, Glantz PO, Svensson SA, et al. Reflection photoelasticity: a new method for studies of clinical mechanics in prosthetic dentistry. Dent Mater 2003;19(2):106-17.
3. Topbasi B, Gunday M, Bas M, et al. Two-dimensional photoelastic stress analysis of traumatized incisor. Braz Dent J 2001;12(2):81-4.
4. Leretter M, Sinescu C. Aspecte de fotoelasticitate ale unui incisiv traumatizat - studiu bidimensional. Tinerii si cercetarea multidisciplinara, Timisoara: Mirton, 2002.
5. Bratu D, Nussbaum R. Bazele clinice si tehnice ale protezarii fixe, Timisoara: Signata, 2001.
6. Maalhagh-Fard A, Wagner WC. Repair of fractured framework: scanning electron microscopy and energy dispersive X-ray spectroscopy. Implant Dent 2004;13(3):197-201.
7. Bardin F, Cobo A, Lopez-Higuera JM, et al. Optical techniques for real-time penetration monitoring for laser welding. Appl Opt. 2005;44(19):3869-76.
8. Helvatjoglu-Antoniades M, Papadogiannis Y, Lakes RS, et al. Dynamic and static elastic moduli of packable and flowable composite resins and their development after initial photo curing. Dent Mater 2006;22(5):450-9.
9. Zandinejad AA, Atai M, Pahlevan A. The effect of ceramic and porous fillers on the mechanical properties of experimental dental composites. Dent Mater 2006;22(4):382-7.
10. Al-Ali S, Oshida Y, Andres CJ, et al. Effects of coupling methods on galvanic corrosion behavior of commercially pure titanium with dental precious alloys. Biomed Mater Eng 2005;15(4):307-16.
11. Chao Y, Du L, Yang L. Comparative study of the surface characteristics, microstructure, and magnetic retentive forces of laser-welded dowel-keepers and cast dowel-keepers for use with magnetic attachments. J Prosthet Dent 2005;93(5):473-7.