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EMBOSSED DIFFRACTION GRATING AND ITS APPLICATION IN EXPERIMENTAL MECHANIC
LISOVANÁ DIFRAKČNÍ MŘÍŽKA A JEJÍ POUŽITÍ V EXPERIMENTÁLNÍ MECHANICE

Václavík J., Bártík J., Minster J., Houha R.[1]

The stuck foil-embossed diffraction grating has been developed for the use in experimental mechanics. The main aim of the contribution is description of using this grating and its application in the field of moiré interferometry, holographic grating interferometry and with laser extensometer.

Keywords

Laser, moiré interferometry, grating interferometry, laser extensometer, diffraction grating, strain gauge.

Several optical contact-less methods are used in experimental mechanics to supplement or substitute the strain gauge measurements. The methods using specimen surface grating are most popular in this field for satisfactory resolution and strain sensitivity. The aim of presented work was the development and manufacture of the diffraction grating, its transfer to the specimen and performance of some initial measurements.

The high frequency f = 1200 mm-1 sinusoidal cross diffraction grating master has been produced using holographic interferometry. The modified technology of embossed holography has been used for production of specimen grating from this master. The principle was embossing of nickel copy of the grating relief to the suitable carrier. As a result of this step, the diffraction grating has been obtained as a copy in a special polymer foil with thickness of 50 μm and as a copy in a standard CD disc. Both of these carriers have thin aluminium layer; remaining on the specimen surface after the transferring process, which includes gluing the carrier and its replacing after glue hardening. All presented results have been performed using this procedure.

As a first example, the distribution of strain field in the front of crack obtained during the dynamic cycling of the CTT aluminium specimen is shown. It should show the ability of the grating to measure as small as high strains using moiré interferometry standard set-up. The grating was glued on to the specimen after dynamic cycling in a special loading device under static load. The interferograms have been obtained after the load had been released using two axes two beams polarization interferometer, which makes it possible to observe and record both u and v displacement fields at the same time. The used interferometer is shown in Fig.l. Both u and v interference fringe pattern displacement fields are presented in Fig.2.

[1] *ŠKODA Výzkum s.r.o.,Tylova 57,31600 Plzeň, jaroslav.vaclavik@skoda.cz, UTAM AVČR Praha, Optaglio s.r.o.,Řež*

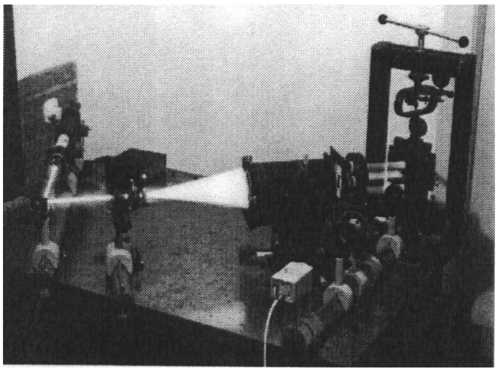

Fig.l Used interferometer for tests

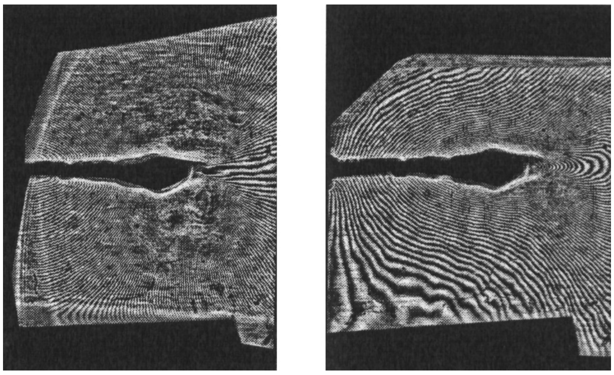

Fig.2 Moiré interferograms: u and v displacement fields

As a second example, the grating interferograms of welded node of trolleybus window are shown in Fig.3. These interferograms have been made from one hologram using grating, glued on the specimen; the reconstruction was performed in four directions. The evaluation of strain component along the profile from these interferograms is shown in Fig.4. Here, the comparison with strain gauge (SG) measurement is made, too. The high stress peak, not observable with strain gauges, is clearly seen from evaluated optical data.

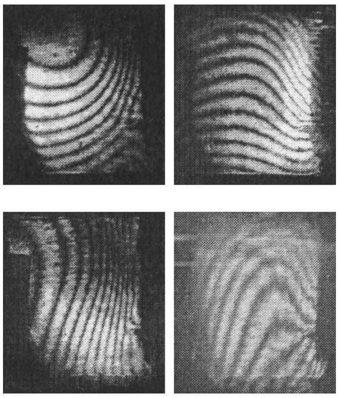

Fig.3 Grating interferograms

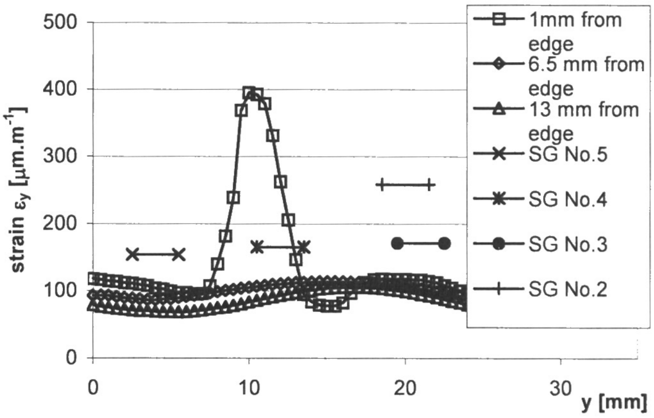

Fig.4 Grating and SG strains ε_y

As a third example, using the grating in laser extensometer set-up is shown. Here, the grating was glued on rectangular specimen with central hole under three point bending. The specimen distortion was derived from diffraction angle change of +1 and -1 diffracted unexpanded laser beams. The evaluation of longitudinal stress component εx at two points, first nominal and second at the hole edge is show in Fig. 5. The comparison with strain gauge measurement is made here, too.

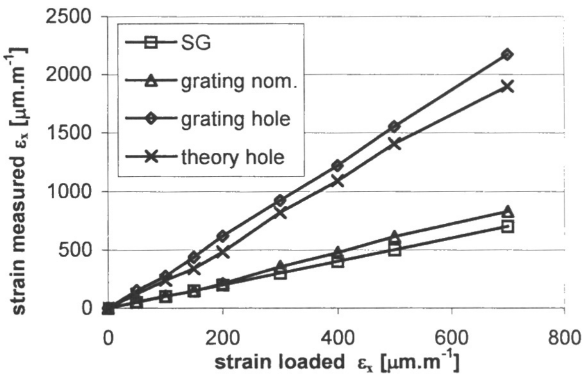

Fig. 5 Extensometer and SG strain ε_y

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