Laboratory 4

Disk in Diametral Compression Using StereoDIC Imaging Systems and VIC-EDU

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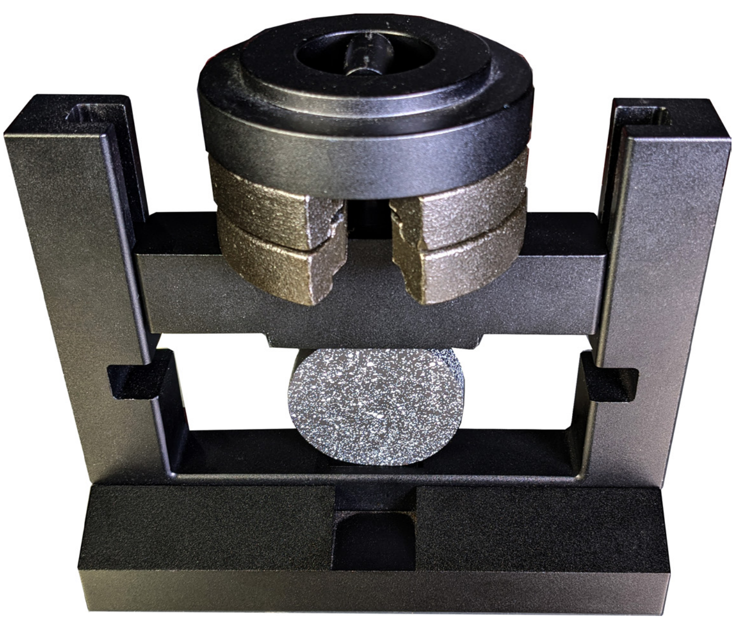
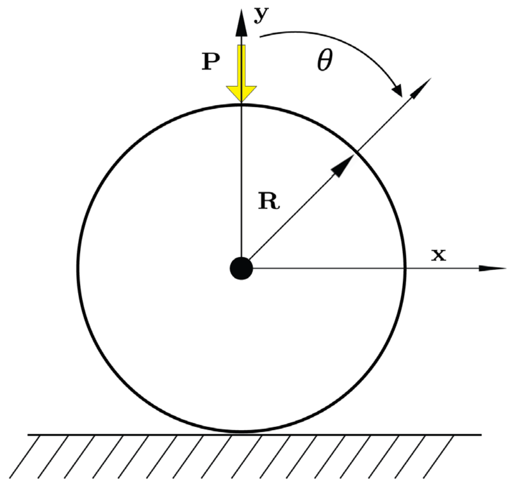


I. OVERVIEW

The purpose of this laboratory is to utilize optical imaging systems with stereo digital image correlation within VIC-EDU [1] to make full-field, non-contacting surface deformation measurements with the educational measurement system for a circular disk loaded in diametral compression. As part of this laboratory, students will be provided basic theoretical background to predict the surface displacements and strains that they will measure on the disk. To obtain the measurements, students will learn how to (a) prepare the specimen surface and apply a usable, high-contrast speckle pattern, (b) arrange the VIC-EDU system to acquire images that can be used for stereo analysis, (c) calibrate the VIC-EDU system for stereo DIC, (d) acquire and store images during mechanical loading of the specimen, (e) perform post-processing to obtain results using the stereo images and (f) compare the experimental results to the theoretical solutions.



central $x - y$ coordinate system

II. DISK IN DIAMETRAL COMPRESSION THEORY

A schematic diagram for a disk in diametral compression is shown in Figure 1. For an isotropic, homogeneous, elastic material, there are existing theoretical solutions for the deformations of the disk [2]. Figure 2 shows the variables used in the solutions obtained in [2]. Of particular import is the angle θ. As shown in Figs.1 and 2, the angle is defined as positive clockwise from the y-axis. This definition is different from most applications, so it is important to be aware of this definition. Because of this definition, the position of an arbitrary point, p, is (r, θ) in a cylindrical polar coordinate system and $(x = r\,sin(\theta), y = r\,cos(\theta))$ in a centrally located $x - y$ system.

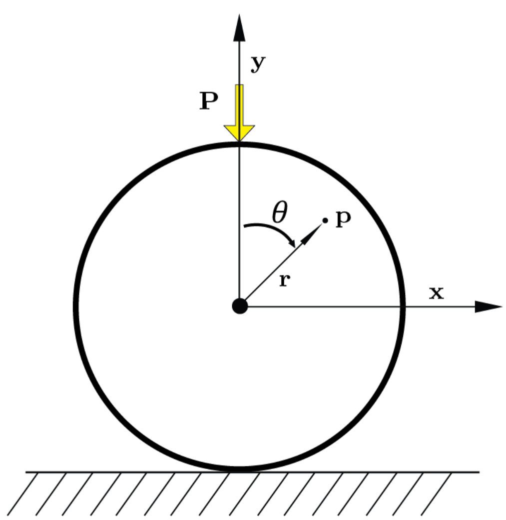
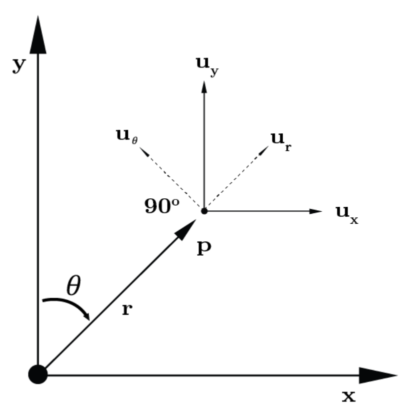


Figure 2a: Disk in diametral compression with angle θ and radial distance r for arbitrary point, p, in the disk



$$\theta = \tan^{-1}(x/y)$$

Figure 2b. Definition of angle, θ; normalized radial position, $\rho = r/R$; displacement components (u_r, u_θ) in the $r - \theta$ coordinate system; displacement components (u_x, u_y) in the $x - y$ coordinate system

The general expressions for the radial and angular displacements were obtained in previous work [1] and are given in the Appendix. Note that the expressions in the Appendix are for the special case where both sides of the disk move in the vertical direction. The predictions for the vertical displacement have been slightly modified in the remainder of this laboratory to account for a fixed point at the bottom of the specimen.

For a horizontal line along the + x-axis with y = 0, angle $\theta = +\frac{\pi}{2}$ and $0 \le \rho \le 1$, the displacement components (u_x, u_y) can be written as follows;

(1)
$$u_x\left(\rho,\frac{\pi}{2}\right) = -\frac{2P}{E\pi t}\left\{-\frac{\rho}{\rho^2+1}[(\rho^2+3)-v(1-\rho^2)]+2(1-v)\tan^{-1}\rho\right\}$$
$$u_y(\rho,\tfrac{\pi}{2}) = C(P)$$

$C(P)$= vertical displacement of center-point located at (0,0) for load P.

For the horizontal line through center-point along the -x-axis with y = 0, angle $\theta = -\frac{\pi}{2}$ and $0 \le \rho \le 1$, the displacement components (u_x, u_y) can be written as follows;

(2)
$$u_x\left(\rho,-\frac{\pi}{2}\right) = -\frac{2P}{E\pi t}\left\{-\frac{\rho}{\rho^2+1}[(\rho^2+3)-v(1-\rho^2)]+2(1-v)\tan^{-1}\rho\right\}$$
$$u_y(p,\tfrac{-\pi}{2}) = C(P)$$

where P is the applied load, $\rho = \frac{r}{R}$,R is the outer radius of the disk, r is the radius to an arbitrary point in the disk, θ is the angle defined in Figs 1 and 2, t is the thickness of the disk, E is the elastic modulus for the disk, v is Poisson's ratio and G is the shear modulus for the disk. The specimen provided with the VIC-EDU system has an estimated modulus of elasticity, E ~ 20 GPa and v ~ 0.40. The shear modulus, $G = E/2(1+v)$, is determined from the estimated values for E and v. As described in a NOTE in Section VI of this Lab, there may be variability in E due to manufacturing differences for the as-supplied specimen material. Here, $\tan^{-1} 0 = 0$ for $\rho = 0$ along x-axis and $\tan^{-1}(1) = \frac{\pi}{4}$ at the right edge of the disk where $\rho = \frac{R}{R} = 1$. The parameter, $C(P)$, can be viewed as the total downward displacement at point (0,0) of the bottom half of the cylindrical disk ($\frac{\pi}{2} \le \theta \le \frac{3\pi}{2}$) due to the applied load, P.

By symmetry of the loaded specimen in the (r, θ) system about the y-axis , the strains along the +x-axis ($\theta = \frac{\pi}{2}$) and -x-axis ($\theta = -\frac{\pi}{2}$) can be written as follows:

(3)
$$\varepsilon_{xx}\left(\rho,\frac{\mp\pi}{2}\right) = \frac{P}{E\pi Rt}\left\{\left(\frac{1-\rho^2}{1+\rho^2}\right)^2 - v\left[\frac{\rho^8+4\rho^6+2\rho^4-4\rho^2-3}{(1+\rho^2)^4}\right]\right\}$$
$$\varepsilon_{yy}\left(\rho,\frac{\mp\pi}{2}\right) = \frac{P}{E\pi Rt}\left\{\left[\frac{\rho^8+4\rho^6+2\rho^4-4\rho^2-3}{(1+\rho^2)^4}\right] - v\left(\frac{1-\rho^2}{1+\rho^2}\right)^2\right\}$$

For a vertical line along the $+y$-axis with x = 0, the elastic displacements are as follows:

(4)
$$u_r(\rho,0) = u_y(\rho,0) = -\frac{2P}{E\pi t}\left\{-(1-v)\rho + 2\ln\left|\frac{1+\rho}{1-\rho}\right|\right\} - |C(P)|$$
$$u_\theta(\rho,0) = u_x(\rho,0) = 0$$

For a vertical line along the + y-axes with x = 0, ε_{xy} = $\varepsilon_{r\theta}$ = 0 and the elastic strains are;

$$\varepsilon_{rr}(\rho,0) = \varepsilon_y(\rho,0) = -\frac{P}{E\pi Rt}\left\{\frac{3+\rho^2}{1-\rho^2}+v\right\}$$

(5)

$$\varepsilon_{\theta\theta}(\rho,0) = \varepsilon_x(\rho,0) = \frac{P}{E\pi Rt}\left\{1+v\frac{3+\rho^2}{1-\rho^2}\right\}$$

$$\varepsilon_{r\theta}(\rho,0) = \varepsilon_{xy}(\rho,0) = 0$$

Similar results are also obtained for all strains for the $-y$ axis (i.e., where $\theta = \pi$).

III. EXPERIMENTAL PREPARATIONS

NOTE Throughout these labs, we refer to the VIC-EDU system in two ways. The hardware (case, cameras, cords, calibration targets) are referred to as "VIC-EDU" and the software (the special version of VIC-3D and VIC-Snap that are designed for this system) as "VIC-3D (EDU)" and "VIC-Snap (EDU)".

III.a. Specimen Preparation

To make accurate DIC measurements using images of a specimen, the specimen must be prepared and the FRONT SURFACE patterned with high contrast speckles having the appropriate size and an approximately random distribution across the field of view. The procedures to do this are detailed in Lab 1 and in Application Note AN-1701 [3] and are briefly summarized below:

- Use coarse and fine grit sandpaper to smooth surface and remove unwanted adherent materials
- Use CSM-2 degreaser or similar cleaning agent to remove any residual oils and metal particles left on the surface by sanding. Repeat this as needed
- Allow surface to dry and then paint the specimen surface. DO NOT paint specimen in same room where imaging is performed, as it will degrade the optical imaging elements. Typically, surface is initially painted white
- Use only enough paint to coat surface and minimize reflections; DO NOT OVERPAINT SURFACE
- After the white paint has dried, apply a random black dot pattern with size of 0.026" (0.635 mm) using the supplied roller and ink pad. Patterning should require approximately 2-3 passes in order to achieve the high contrast 50/50 ratio of white to black that is best. Do not try to align the roller passes, as attempts to move the roller around during patterning will smear or blur the dots, potentially degrading the quality of stereo DIC measurements. When done, image the front surface and check the pattern with VIC-3D (EDU) tools.

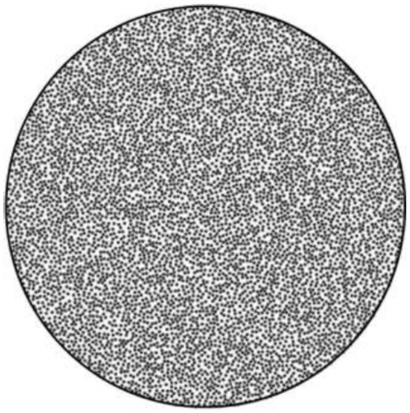


Figure 3: Image of a typical patterned disk specimen

III.b. Installing Specimen in Loading System

Once the specimen has been prepared and placed in the mechanical loading frame, the loading and displacement conditions used in the theory should be approximated as best possible. Thus, when setting up the experiment, care should be taken to try and configure the loading and support conditions to approximate these conditions. These BCs are as follows;

- Vertical compressive loading will be applied on top surface along the y-axis, so $F_y = -P$
  - Loading should be applied equally across the entire disk thickness so that the front surface is approximately in a plane stress condition
- Bottom contact point on disk does not have any displacement so that the displacement (d_x, d_y) at the bottom of the disk is $(0,0)$.

III.c. VIC-EDU System Preparation

Once the specimen is in the loading frame, the as-suppled tripod should be located in front of the specimen and the VIC-EDU system firmly attached to the tripod mounting head. At this point, the VIC-EDU system should be powered up and oriented to obtain images of the front surface of the specimen. Once the system is operational, the procedures outlined in Lab 1 and the User's Manual for focusing the specimen and preparing to acquire images should be re-read and then used to locate the system in a position where focused images can be obtained. At this point, calibration of the system should be performed.

III.d. VIC-EDU System Calibration

Once the VIC-EDU system is mounted to the tripod and placed in position where the specimen is in sharp focus, system calibration is performed. Though in principle the entire system could be picked up and moved carefully to a new location for calibration, and then moved back into position for viewing the specimen without affecting the measurements, such movements may introduce changes in the optical imaging system that are not readily apparent and can affect the accuracy of the results. To minimize the potential for such errors, it is recommended that you calibrate in front of the test specimen. There should be enough depth of field to allow for this. Lighting provided within the VIC-EDU measurement head should provide bright, clear images of the as-supplied calibration target.

When performing calibration, it is recommended that the target occupy 80-90% of the field of view. For this experiment, the as-supplied target dot pattern has black dots with a 14mm spacing on a white background. Fig. 4 shows a typical dot pattern imaged by the VIC-EDU system. Furthermore, it is required that all three of the black dots containing a central white dot be within the field of view of both cameras. These dots provide the necessary information for estimating rotation of the planar target.

To perform calibration, the target should be in focus for both cameras. Since the focus is fixed on the VIC-EDU system, the target should be located approximately 0.50m in front of the system. Then, the target is rotated several times and focused images acquired. The rotations should include motions about three separate orthogonal axes to ensure accurate identification of all calibration parameters. Typically, between 25 and 50 calibration images are acquired. Please refer to Lab 1 and the User's Manual for additional information regarding calibration and processing of the calibration images.

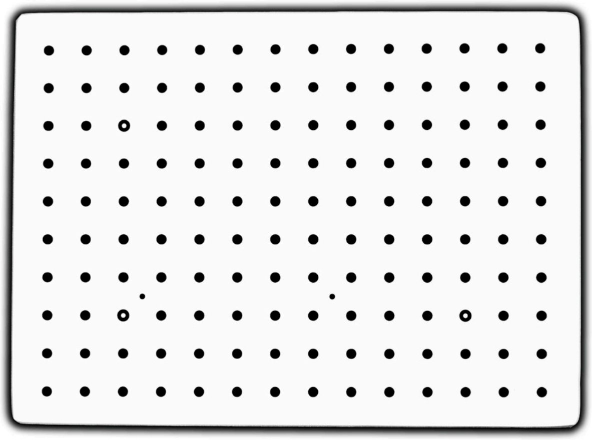


Figure 4: Photograph of a typical calibration target used to calibrate stereo-vision measurement systems such as VIC-EDU

IV. PERFORMING EXPERIMENT WITH IMAGE ACQUISITION

Once calibration is successfully completed in front of the specimen, the target is removed so the front surface of the beam specimen already placed in the loading frame is visible and in focus.

- Read Lab 1 and VIC-EDU User's Manual regarding the procedure for initiating VIC-EDU to acquire and store image pairs for this experiment.
- Acquire several image pairs of the speckled front surface of the specimen in the unloaded state.
- Apply the first increment of load/displacement and acquire two to three pairs of images, recording the image numbers and the corresponding applied load/displacement.
- Continue load/displacement application and image acquisition process until you reach the pre-identified maximum load or displacement for this specimen.
- Terminate the image acquisition process and the experiment via the process described in Lab 1 (e.g., close VIC-Snap (EDU).
- Unload the specimen.

At this point, the experimental process is complete and the deformation data is embedded in the image pairs that were acquired during the experiment. To extract the full-field deformation data, the VIC-3D (EDU) software is initiated to analyze the images. Please refer to the detailed description in Lab 1 for how to initiate VIC-3D (EDU) and extract displacement and strain data using the software functions available in the code.

V. IMPLICATIONS OF THEORY FOR DISK FRONT SURFACE MEASUREMENTS

With symmetry in the (r, θ) system about the y-axis, all points along the y-axis are predicted to have $u_x(0, y) = 0$ as shown in Eq (4). This can be checked experimentally by simply plotting u_x along the y-axis from the top to the bottom of the disk; any deviation of the u_x measurements from 0 should be randomly varying around 0. However, if there is a clear trend or a translation of the disk in the x-direction, this would indicate that motions other than those predicted by the theory have occurred. In fact, such motions often arise in actual experiments so that the specimen does not just deform due to load, but also moves and rotates due to variations in the boundary conditions. Such motions are known as **Rigid Body Motions (RBMs)** and are quite common in experiments. The presence of RBMs may need to be accounted for when looking to compare the experimental and theoretical displacements. This may be the cause for any motions at the bottom of the disk since the supports under the disk may deform or even rotate slightly, adding rigid body motions to points on the disk.

NOTE You can remove rigid body motion from the displacement measurements using a "rigid body motion removal" function in the software. Please use this function as needed to see if there has been rigid body motion. Once the rigid body motion has been removed, then the resulting data should be due to true deformation of the specimen and hence consistent with the theoretical results.

Inspection of Eqs. 4 and 5 shows that, for point loads at the top and bottom of the specimen, the displacement and strain at a point under the load are singular. The theoretical predictions near the point load and the bottom contact point will not be accurate in our experiments since the load will be distributed over a small area on the top (and bottom) surfaces when load is applied, making the results non-singular at these points.

As noted earlier, physical boundary conditions require that the bottom point on the disk does not displace. To account for this boundary condition, the parameter, $C(P)$, in Eq. 4 is required. For the displacement component, u_y, $C(P)$ can be interpreted as the vertical displacement of all points along the x-axis shown in Figs. 1 and 2. Thus, this is the displacement of the top of the bottom half of the disk, designated as $-\delta$. Since the load point on the disk also displaces downward relative to the x-axis by the same amount as the bottom half of the disk deflects downward, then the displacement of the load point on the disk will be the sum of both displacements, $u_y(1,0) = -2\delta$.

NOTE You can check the "assumed rigid" lower boundary by outputting displacement data for a subset located just above the contact point at the bottom of the disk. You can also check on the displacement just below the loading point. Displacements at a point just BELOW the loading point can be measured and then compared to the theoretical prediction at the same point for the same load. Here, the displacement should be $2\,C(P)$.

Another potential source of error is that finite-sized subsets are used to obtain the displacement at the center-point of the subset. This process will average the displacements over the subset size and thus may introduce slight shifts in the VIC-EDU measurement, especially in regions where there are high gradients in the displacements. Typically, the averaging process tends to underestimate the subset center-point displacement.

Interestingly, RBM does not affect the comparison of experimental and predicted strains, since strains in VIC-EDU are defined in a way that eliminates the effect of RBM on its value. So, even if there is RBM that affects the comparison of displacements, the measured and predicted strains such as ε_{xx} should be comparable. Issues that might affect the quality of the comparison include slight shifts in the load position relative to the assumed location $(0, R)$, accuracy of the measured geometric lengths and accuracy of the assumed modulus of elasticity, as well as other factors that are not noted here (e.g. temperature changes during the experiment).

An additional source of potential error is the way in which the experimental data is processed. For example, the experimental strains obtained from VIC-EDU use the measured displacements in a region, with a "finite-size strain filter" to estimate the strains at a point. The strain filter has various sizes over which it acquires the strain. This process may introduce slight shifts in the strain relative to the actual strain at the corresponding point on the specimen.

VI. LABORATORY RESULTS TO BE PRESENTED

1. Measure the specimen geometry (d, t) several times with a micrometer or similar device and provide a table of the individual results, mean value for each dimension and standard deviation for each dimension.

The range on the modulus of elasticity, E, for the disc material is 10 MPa ≤ E ≤ 30 Mpa, with a best estimate of 20Mpa. For ν, the indicated range is 0.33 ≤ ν ≤ 0.47, with a best estimate of 0.40.

2. Use two sets of stereo images obtained with P = 0 and obtain full-field strain data for ε_{yy} using the subset size and subset spacing to be used in future analyses and show plot.

- Obtain mean value and standard deviation in experimentally measured strain for the points where strain was obtained in the disk.
- Use these values to discuss how the observed variability will impact results.

3. Estimate the location of the disk center-point and define both y and x axes in the images having this center-point as the origin. For six applied loads;

$$P = 0, \frac{P_{max}}{5}, \frac{2P_{max}}{5}, \frac{3P_{max}}{5}, \frac{4P_{max}}{5} \ and \ P_{max}$$

(a) Output full-field plots of experimentally determined u_x and u_y.

- Looking at all the plots, determine whether there is SYMMETRY in the data relative to the y-axis and discuss what you observe in the graphs.
- Looking at a point near the bottom of the disk (x = 0, $y \approx -R$), determine whether the displacements are consistent with the assumed boundary condition or not.

Remember, you can use the rigid body removal option in VIC-EDU and see how the displacement results compare before and after removing rigid body rotations and displacements

(b) Output the strain ε_{yy} along the line (0, y) for all y in the range $-\frac{R}{2} \leq y \leq +\frac{R}{2}$

- Compare the strain along this line to the theoretical prediction for each load using mean values in the geometric parameters.

(c) Output the strain ε_{xy} along the line (0, y) for all y in the range $-\frac{R}{2} \leq y \leq +\frac{R}{2}$

- Compare the strain along this line to the theoretical prediction for each load. Note that the theory predicts no shear strain along a line of symmetry using mean values in the geometric parameters.

You can use the rigid body removal option in VIC-EDU again, and see how the strains results compare before and after removing rigid body motions. Note that, theoretically, the strain fields should be the same either way.

4. At a point near the top of the disk (e.g., near (0, R)), output the vertical displacement for ALL loads. Similarly, for a point at the center of the disk (e.g., subset with center at approximately (x = 0, y = 0)), output the vertical displacement for ALL loads.

- Plot P vs measured $u_y(0, R)$ and u_y(0,0) on the same graph and compare these results by looking at ratio $\frac{u_y(0, R)}{u_y(0, 0)}$ for each load, P. Discuss what you observed.

If the previous displacement results required rigid body removal to agree with the theoretical predictions, you will need it here. So, it would be interesting to plot the results before and after removing rigid body rotations and displacements.

5. For six applied loads, $P = 0, \frac{P_{max}}{5}, \frac{2P_{max}}{5}, \frac{3P_{max}}{5}, \frac{4P_{max}}{5}$ $and\ P_{max}$, output the experimental strain $\varepsilon_{xx}(x, y = 0)$ for $-R \leq x \leq +R$

   - Calculate the therorectical $\varepsilon_{xx}(x, 0)$ for $-R \leq x \leq +R$ and compare the theory and experimental strains for the six loads.

Discuss the results shown above, with special emphasis on whether there is evidence of rigid body motion or not in any of the comparisons.

VII. APPENDIX

General Expressions for Elastic Displacements and Strains for Disk in Diametral Compression

The displacements u_r and u_θ at any point in a diametrically loaded disk subjected to point load P were derived in [2] and are written as follows;

$$u_r = -\frac{2P}{\pi}\left\{\left[\frac{\rho[2+\rho^2+\rho^4-(1+3\rho^2)\cos 2\theta]}{1+\rho^4-2\rho^2\cos 2\theta} + \sin\theta\left(\tan^{-1}\frac{\rho\sin\theta}{1+p\cos\theta} + \tan^{-1}\frac{\rho\sin\theta}{1-\rho\cos\theta}\right) + \cos\theta\ln\left|\frac{1+\rho^2+2\rho\cos\theta}{1+\rho^2-2\rho\cos\theta}\right|\right] + v\left[\frac{\rho(1-\rho^2)(\rho^2-\cos 2\theta)}{1+\rho^4-2\rho^2\cos 2\theta}\sin\theta\left(\tan^{-1}\frac{\rho\sin\theta}{1+\rho\cos\theta} + \tan^{-1}\frac{\rho\sin\theta}{1-\rho\cos\theta}\right)\right]\right\}$$

$$u_\theta = -\frac{2P}{\pi}\left\{\left[\cos\theta\left(\tan^{-1}\frac{\rho\sin\theta}{1+p\cos\theta} + \tan^{-1}\frac{\rho\sin\theta}{1-\rho\cos\theta}\right) - \sin\theta\left(\frac{2\rho(1-\rho^2)\cos\theta}{1+\rho^4-2\rho^2\cos 2\theta} + \ln\left|\frac{1+\rho^2+2\rho\cos\theta}{1+\rho^2-2\rho\cos\theta}\right|\right)\right] - v\cos\theta\left[\frac{2\rho(1-\rho^2)\sin\theta}{1+\rho^4-2\rho^2\cos 2\theta} + \tan^{-1}\frac{\rho\sin\theta}{1+\rho\cos\theta} + \tan^{-1}\frac{\rho\sin\theta}{1-\rho\cos\theta}\right]\right\} \quad \text{(A-1)}$$

where P is the applied load, R is the outer radius of the disk, r is the radius to an arbitrary point in the disk, $\rho = \frac{r}{R}$, θ is the angle defined in Fig. 2, t is the thickness of the disk, E is the elastic modulus for the disk, ν is Poisson's ratio and G is the shear modulus for the disk. If the displacements are to be obtained in the $x-y$ system, then the same displacement in the $x-y$ system is written;

(A-2)
$$u_x = u_r \sin\theta - u_\theta \cos\theta$$
$$u_y = u_r \cos\theta + u_\theta \sin\theta$$

Eqs. A-1 and A-2 must be used to obtain the displacements (u_x, u_y) in the disk for comparison to the theoretical predictions, since VIC-EDU reports displacements in the $x-y$ system.

Regarding the strains in the disk, it also was shown in [2] that the strains in the $r-\theta$ system are as follows.

(A-3)
$$\varepsilon_{rr} = \frac{P}{E\pi Rt}\left\{\frac{(1-\rho^2)^2(\rho^4+2\rho^2-1-2\cos 2\theta)}{(\rho^4+1-2\rho^2\cos 2\theta)^2}\right\} - \nu\frac{P}{E\pi Rt}\left\{\frac{\rho^8+4\rho^4-4\rho^2-1+2(-2\rho^6+\rho^4+1)\cos 2\theta}{(\rho^4+1-2\rho^2\cos 2\theta)^2}\right\}$$

$$\varepsilon_{\theta\theta} = \frac{P}{E\pi Rt}\left\{\frac{\rho^8+4\rho^4-4\rho^2-1+2(-2\rho^6+\rho^4+1)\cos 2\theta}{(\rho^4+1-2\rho^2\cos 2\theta)^2}\right\} - \nu\frac{P}{E\pi Rt}\left\{\frac{(1-\rho^2)^2(\rho^4+2\rho^2-1-2\cos 2\theta)}{(\rho^4+1-2\rho^2\cos 2\theta)^2}\right\}$$

$$\varepsilon_{r\theta} = \frac{P}{G\pi Rt}\left\{\frac{2(1-\rho^4)(1-\rho^2)\sin 2\theta}{(\rho^4+1-2\rho^2\cos 2\theta)^2}\right\}$$

where E, is modulus of elasticity, ν is Poisson's ratio and G is the shear modulus with

$$G = \frac{E}{2(1+\nu)}$$

The transformation of strains from the $r-\theta$ system to the $x-y$ system follows the general process outlined in undergraduate mechanics of materials. However, here there is a slight change in the equations since the angle θ is different than is commonly used. The strains in the $x-y$ system are as follows.

(A-4)
$$\varepsilon_{xx} = \varepsilon_{rr}\sin^2\theta + \varepsilon_{\theta\theta}\cos^2\theta - 2\varepsilon_{r\theta}\sin\theta\cos\theta$$
$$\varepsilon_{yy} = \varepsilon_{rr}\cos^2\theta + \sin^2\theta\,\varepsilon_{\theta\theta} + 2\varepsilon_{r\theta}\sin\theta\cos\theta$$
$$\varepsilon_{xy} = -1 * [(\varepsilon_{rr} - \varepsilon_{\theta\theta})\sin\theta\cos\theta + \varepsilon_{r\theta}(\sin^2\theta - \cos^2\theta)]$$

It is important to emphasize that Eqs. (A-3) and (A-4) must be used to convert the $r-\theta$ strains into the $x-y$ strains as $x-y$ strains are reported by VIC-3D (EDU) when analyzing the experimental images of the loaded calibration disk. Furthermore, if the strains are obtained using Eqs. (A-3) and (A-4), then the definition of the angle θ requires that the shear strain equation be multiplied by −1 to obtain the same sign as is used in VIC-EDU. The −1 factor already is included in the shear strain formula in Eq. (A-4).

Lab 4 - Stereo DIC Image Analysis Parameters

Region of Interest (ROI) (pixels x pixels)	
Field of View (pixels x pixels)	
Digital magnification (pixels/mm)	
Subset size (pixels)	
Subset spacing (pixels)	
Correlation criteria used	
Subset weighting	
Interpolation method	
Consistency threshold (pixels)	
Confidence margin (pixels)	
Matching threshold (pixels)	
Strain metric type	
Strain filter size (N x N pixels^2)	
Strain filter type	
Auto-plane fit	Yes or No

NOTES

VIII. REFERENCES

1. VIC-EDU User's Manual, Correlated Solutions Incorporated, www.correlatedsolutions.com
2. MA Sutton, JJ Orteu, and HW Schreier, Image Correlation for Shape Motion and Deformation Measurements; Theory and Applications, Springer (2009) ISBN: 978-0-387-78746-6.
3. Application Note AN-1701:Speckle Pattern Fundamentals, http://www.correlatedsolutions.com/support/index.php?/Knowledgebase/Article/View/80/1/speckle-pattern-fundamentals.