METHOD OF POISSON'S RATIO IMAGING WITHIN A MATERIAL PART

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The present invention is directed to a method of displaying the Poisson's ratio image of a material part. In the present invention longitudinal data is produced using a longitudinal wave transducer and shear wave data is produced using a shear wave transducer. The respective data is then used to calculate the Poisson's ratio for the entire material part. The Poisson's ratio approximations are then used to display the image.
Step 1
Perform an ultrasonic dry-coupled contact scan over the specimen using a longitudinal wave energy transducer.

Step 2
Perform an ultrasonic contact scan over the specimen using a shear wave energy transducer.

Step 3
Calculate longitudinal and shear wave velocities at each point using the raw waveform data obtained in steps 1 and 2.

Step 4
Calculate the Poisson's ratio from the longitudinal and shear wave velocities calculated at step 3.

Step 5
Convert/normalize all Poisson's ratio values to an integer between 0 and 255.

Step 6
Display the image of the Poisson's ratio.

FIG. 3
METHOD OF POISSON'S RATIO IMAGING WITHIN A MATERIAL PART

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the United States Government and may be manufactured and used for the Government for governmental purposes without the payment of any royalties thereon or therefore.

FIELD OF THE INVENTION

The present invention is directed to a method and apparatus for determining Poisson’s ratio variation within a material part so that it can be displayed for analysis. Poisson’s ratio variations within a material part have been found to contribute to the structural failure of a material part. Poisson’s ratio variations in the form of a pictorial map within the material part were previously unattainable without using intrusive methods. Therefore, in performing prior art numerical analysis the Poisson’s ratio was assumed to be constant, thereby creating a less accurate numerical analysis of the material part.

It is, therefore, an object of the present invention to interrogate the material part using an improved contact scan method that permits dry inspection.

It is a further object of the invention to create accurate numerical analysis by providing the Poisson’s variation within the material part.

It is still a further object of the invention to display the Poisson’s variation within the material part by imaging.

DESCRIPTION OF RELATED ART

U.S. Pat. No. 3,302,044 relates to an ultrasonic probe which is able to detect both longitudinal waves and shear waves. U.S. Pat. No. 4,213,147 is directed to ultrasonic image processing of B scan ultrasonic images. U.S. Pat. No. 4,967,401 relates to an analysis of seismic data used to locate hydrocarbon reservoirs by determining lithographic parameters including Poisson’s ratio. U.S. Pat. No. 5,038,787 is directed to an ultrasonic inspection system designed for the evaluation of bone structures which takes into account Poisson’s ratio.

SUMMARY OF THE INVENTION

The present invention is directed to a method of determining the Poisson’s ratio variation within a material part. A self-aligning transducer assembly is used to perform the ultrasonic contact scan. The assembly enables dry coupled contact scanning of the material part. The assembly is designed using buffer rod faces so that the transducer head will make contiguous contact with the material part. The transducer assembly is then moved repeatedly across the surface of the material part to attain a full image of the entire material part.

The measurements are used to determine the poisson’s ratio variation within a material part. The Poisson’s ratio variation is desired when doing finite element analysis of the material part for more accurate modeling. In the present disclosure, a Poisson’s ratio image is generated by taking discrete measurements of both the ultrasonic longitudinal wave velocity and the shear wave velocity of the material part. The Poisson’s ratio is computed as \( v = \frac{(v_l^2/2 - v_s^2)v(v_l^2 - v_s^2)}{2} \) for each point selected. The poisson ratio for each point is mapped to a gray scale and imaged using the scale values.
approximating said shear wave velocities using said shear wave data,
approximating Poisson’s ratios using the relationship:
\[ v = \left( \frac{v_l^2 - v_s^2}{2v_s} \right), \]
where \( v_l \) is said longitudinal velocity and \( v_s \) is said shear wave velocity,
normalizing said Poisson’s ratios thereby producing normalized data, and
displaying said normalized data thereby imaging said Poisson’s ratio variation within said material part.

2. A method as claimed in claim 1 wherein normalized data is normalized to integer values between 0 and 255.

3. A method as claimed in claim 1 wherein said normalized data is displayed using an 8-bit video image processing system.

4. A method as claimed in claim 1 wherein said normalized data is mapped to a grey scale.

5. A method as claimed in claim 1 wherein first scan is performed using dry-coupling.

6. A method as claimed in claim 1 wherein second scan is performed using dry-coupling.

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