Synthetic rock for seismic modelling

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ABSTRACT

The use of synthetic rock as a physical modelling medium is being assessed by the CREWES Project, University of Calgary. Synthetic rocks with different physical properties are obtained by mixing commercial thermal setting sand with various additives.

INTRODUCTION

Synthetic rock (synrock©) is a combination of a fine grain quartz sand and a thermal setting plastic resin. It was developed in 1988 by Jet Research Center Inc. (JRC) Alvardo, Texas and was supplied to us by Prime Explosives Perforating Supplies Ltd., Calgary. It was designed as a quality control (QC) test target to assess perforator charge performance. An industry standard for QC targets is the Berea sandstone. However, this material has high cost and inconsistent properties, which can give misleading indicators of a charage's performance, when compared to original design specifications.

MANUFACTURE

At the CREWES Project we have mixed synrock with various materials in attempt to change the physical properties of the rock (e.g. velocity and density), to ascertain if synrock can be used as a physical modelling medium.

The test samples were mixed and poured into cylindrical molds and used powdered material freely available. The mixes of synrock were all 400g in weight and additives were from 25g to 300g. The additives were steel shot, glass beads, aluminum oxide, lead powder, saw dust, bentonite, #120 grit and #1000 grit silicon carbide. After mixing, the samples were baked in an oven at 150^{o}C for a period of eight hours, in which the samples changed from a free flowing sand to a rigid porous sandstone.

Some results of the measurements of *P*-wave velocity, *S*-wave velocity, *Vp*/*Vs* and density of various test samples are contained in Figure 1. Some mixes gave unexpected results. For example steel which has a *P*-wave velocity of 5800m/s, when mixed with synrock which has a *P*-wave velocity of 2690m/s resulted in an acoustic velocity of 2461ms (300g steel / synrock). The reason for the decrease in velocity is probably due to limited amount of plastic resin in the synrock. With the addition of the various powders, the surface area increases and the resin does not bond to all the grains of the matrix. Figure 2. shows *P*-wave velocities and *S*-wave velocities for the test samples and the various samples. Figure 3. shows a plot of *Vp* versus *Vs*, indicating a nearly linear relationship between these properties. However, Figure 4., shows little correlation between density and P-wave velocity. This may be due to large differences in porosity between samples.

Material	Vp	Vs	Vp/Vs	Density
SYNROCK	2938.000	1762.000	1.490	2590.000
GLASS 50g	2456.000	1485.000	1.590	2390.000
GLASS 100g	2120.000	1290.000	1.430	2240.000
GLASS 150g	1969.000	1015.000	1.670	2840.000
STEEL 300g	2089.000	1194.000	1.560	3130.000
STEEL 100g	2461.000	1468.000	1.560	2790.000
STEEL 150g	2369.000	1434.000	1.410	2900.000
STEEL 200g	2169.000	1303.000	1.400	2950.000
LEAD 100g	1854.000	1011.000	1.590	2960.000
LEAD 200g	1440.000	869.000	1.490	3450.000
LEAD 300g	1218.000	732.000	1.450	3920.000
SAWDUST 25g	1209.000	718.000	1.440	1740.000
BENTONITE 25g	1383.000	633.000	1.610	2300.000
#1000/50g	1665.000	979.000	1.540	2280.000
#1000/100g	1553.000	467.000	1.410	2330.000
#120/50g	2189.000	1282.000	1.550	2280.000
#120/100g	1979.000	1189.000	1.470	2170.000
WET	2839.000	1672.000	1.490	2460.000
ALUMINUM 25g	1209.000	713.000	1.580	2220.000

FIG. 1. Materials mixed with synrock and their relative properties.

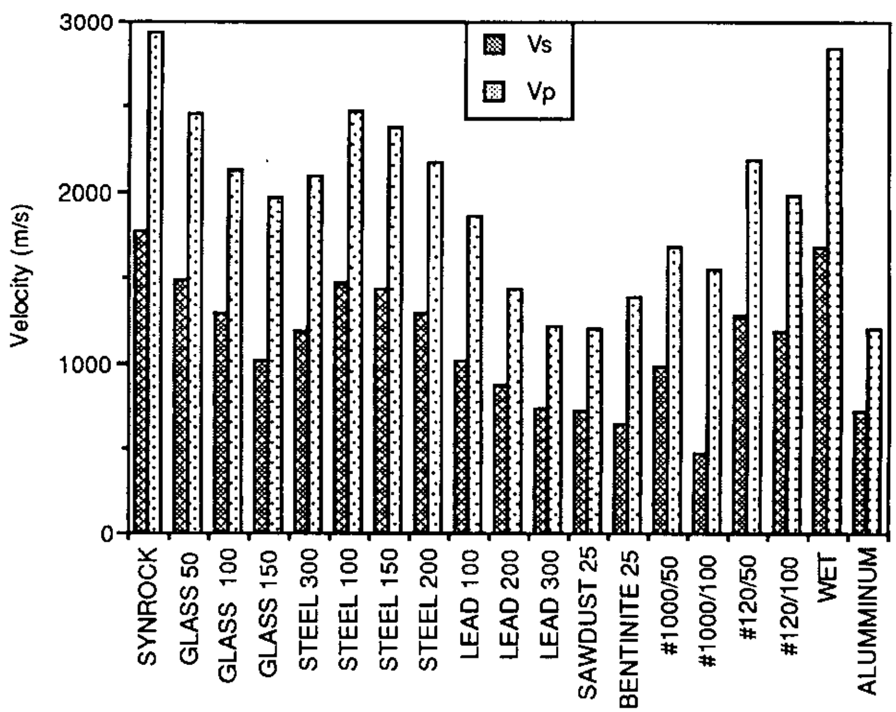

FIG. 2. Graph displays P -wave and S -wave velocities.

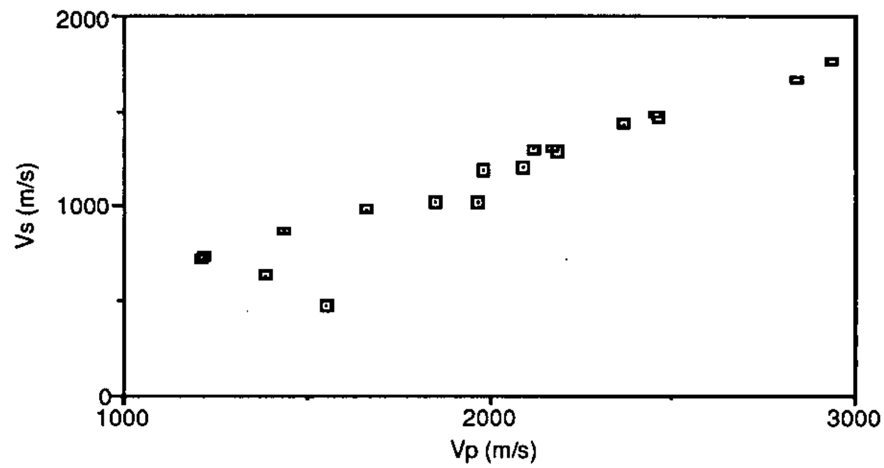

FIG. 3. Chart shows *P*-wave velocity versus *S*-wave velocity.

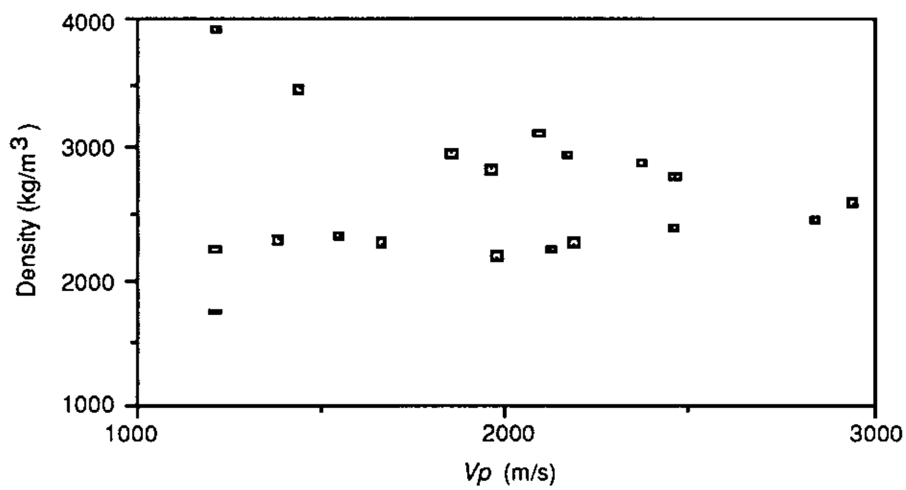

FIG. 4. Chart shows *P*-wave velocity versus density.

CONCLUSION

The synrock samples mixed with aluminum oxide, sawdust, bentonite and #1000 grit silicon carbide, were weak to compression and crumbled easily. Samples mixed with steel shot, glass beads, lead powder and #120 grit silicon carbide were as hard as synrock. In recent test we have demonstrated that we can alter the density and acoustic properties of synrock significantly. We are now in the process of constructing a reef model for acoustic and elastic modelling experiments.

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