In-situ measured Q- factor dependence from load in short and long time periods

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Dynamic loaded large object is under research. Long time periods (8 years) measurements are made by variety loads: from quasi static till strong motion. Short time measurements start from quasi static and load goes step-by-step till strong motion- maximum loaded- and return in the same way to quasi static. This experiment longs 60 minutes. An assessment of material quality factor (Q-factor) in places of measurements was made taking into account the absorbed and emitted energy. The Q-factor for energy is calculated from RMS response spectra curves. The Q-factor and its changes in long time and short time experiments in some MPs are compared. The smaller is the Q-factor, the higher is the concentration of interior invisible cracks. Structural alterations, opening of fractures and their closure under load, and transitional processes are reflected in the spectra of emitted acoustic signals and in the nonlinearity of response Q-factor.

1 Introduction

Non-destructive evolution (NDE) of structures has become very important in forecasting, determining, minimising or preventing problems. An analysis of acoustic emission (AE) signals from structures has been one method of conducting NDE and inspection. The analysis of transient AE signals provides high sensitivity to damage or other changes of conditions and provides the capability to evaluate specimens and structure in real time, so that the damage or other changes in structural integrity can be detected and corrected before a catastrophic failure. AE is cemented granular material response to dynamic load and Q-factor of response spectra is good assessment parameter of degradation process in concrete

Nonlinear behaviour is observed early on in a degradation process, long before linear parameters start to show damage dependent effects. Any increase in the values of nonlinear parameters is univocally related to an increase in micro-structural features in the material considered [3, 4, 5, 6].

2 Description of the site and set-up of experiments

The work was carried out investigating a large (200 x 60 m) reinforced concrete structure foundation under dynamic load; the site and the set-up are shown in Fig.1

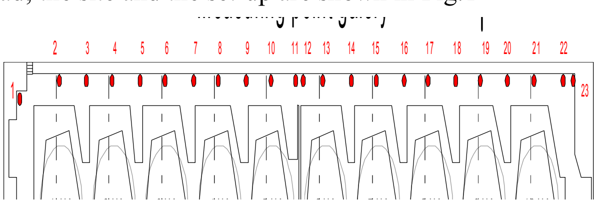


Figure1. 23 MPs (measurement points) in the MPG (measuring point gallery).

Short time experiment start from quasi static and load goes step-by-step till strong motion- maximum loaded- and return in the same way to quasi static. This experiment longs 60 minutes and measurements are made simultaneously in 8 MP.

Long time periods (8 years) measurements are made by variety loads: from quasi static till strong motion in 23 MP.

Fig2- fig4. Illustrate results of short time measurements in MP 1 and figs. Show what happens in the same MP in long time period by variety load

2.1 Short time experiment results

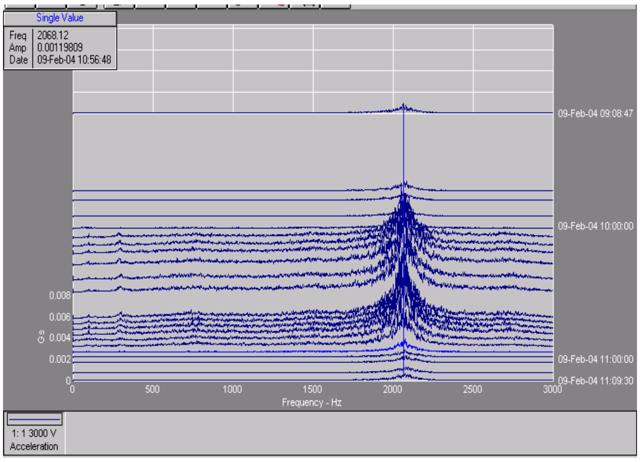


Fig.2 Response RMS spectra, diapason 0-3000 Hz, in MP 1, vertical direction (V). Short time experiment start (fig. upper part) from quasi static and load goes step-by-step till strong motion- maximum loaded, (middle part)- and return in the same way to quasi static. Experiment finished fig. down part. This experiment longs 60 minutes.

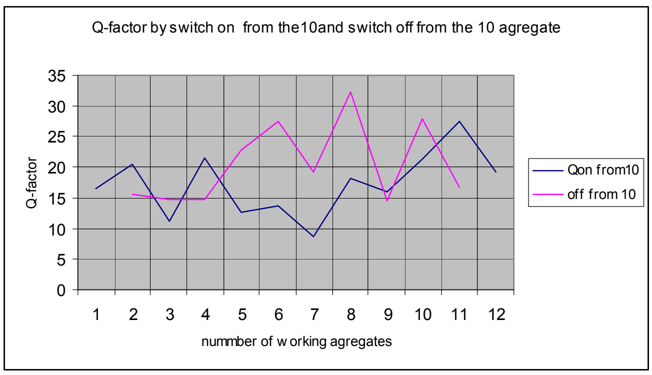
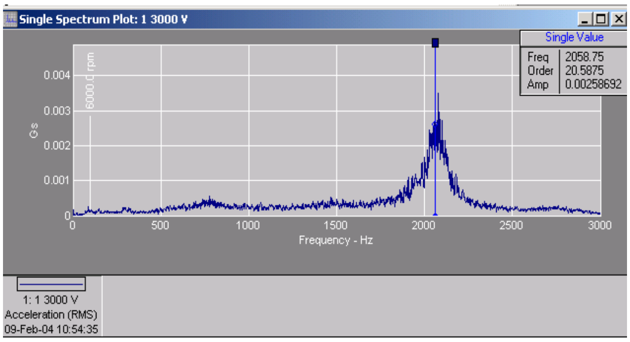


Fig.3 Q factor changes by switch on and switch off 10agregates .Point 1 corresponded silence, point12 corresponded 10 aggregates are working



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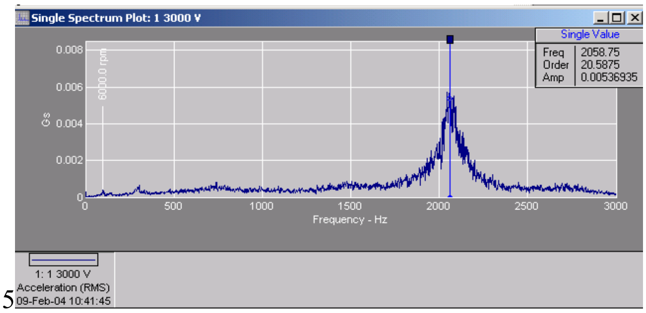

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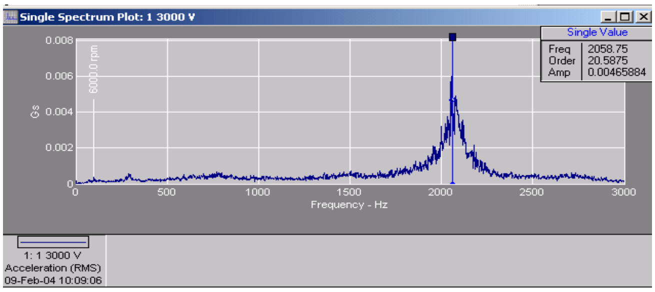

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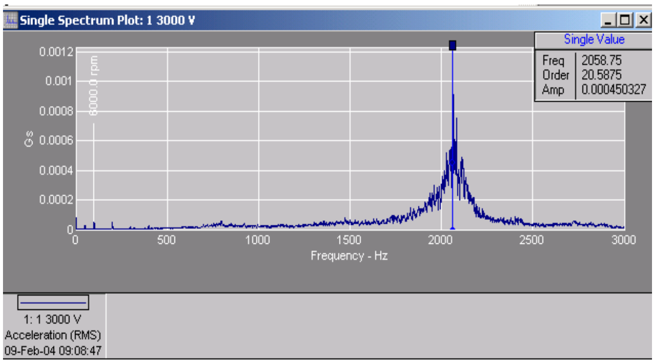

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Fig.4 Response RMS spectra changes by switch on and switch off 10agregates. Experiment start resonance frequency (1) is 2075 Hz. 10 aggregates are working (10) Final resonance frequency (20) is 2058, that mean light pressure going up. Fig. 3 shows Q-factor evolution diapason, it is ~ 9-30, but start and final Q factors are identical

2.2 Long time measurements

.Long time measurements show what happens in the MP in long time period-from 15.04.03 till 26.10.05 by variety load from silence till strong motion

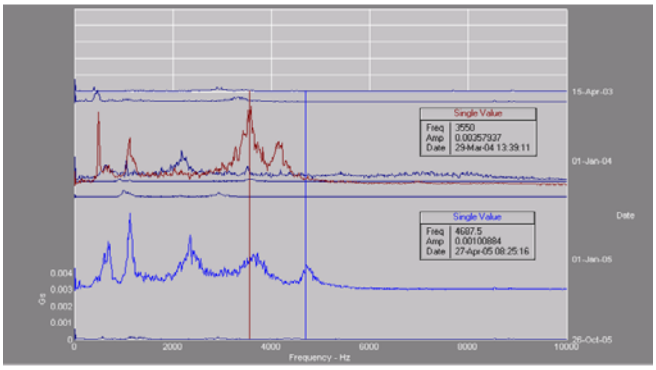


Fig.5 Response spectra MP1 V in long time period-from 15.04.03 till 26.10.05- by variety load from silence till strong motion

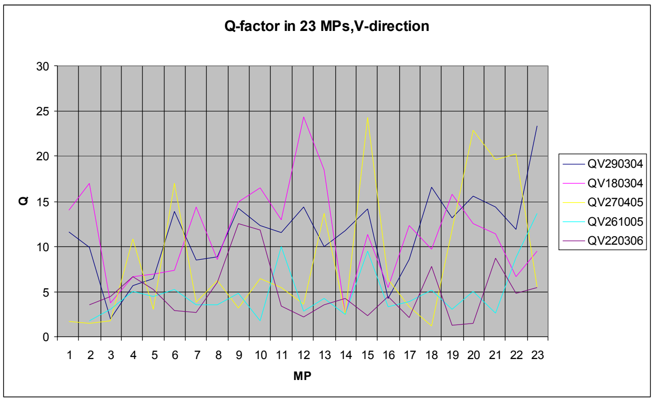
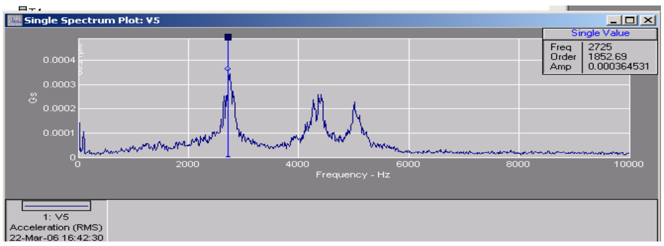
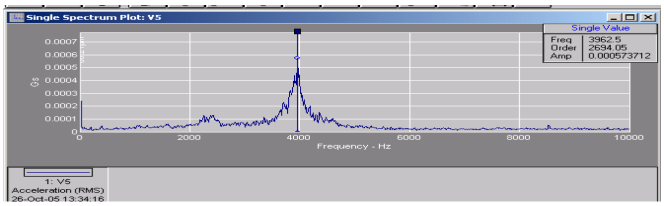


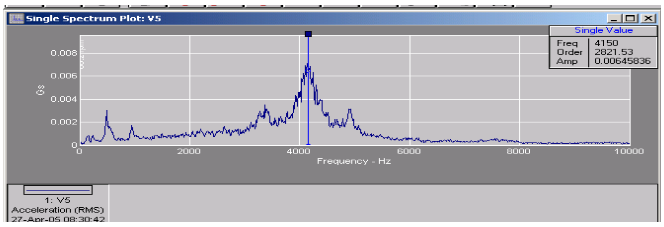
Fig.6 Q-factor changes in 23 MPs V-direction from 18.03.04 -22.03.06. Max. Load (strong motion) 29.03.04



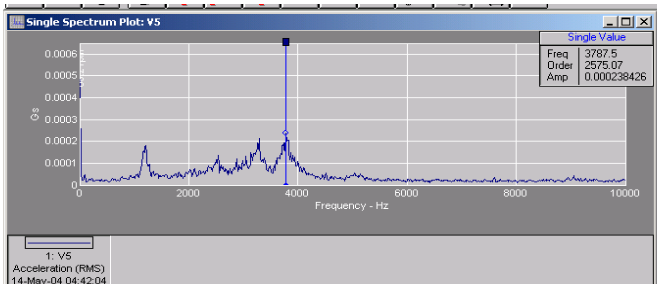
22.03.06; RMS=0, 001735; Q=5, 26



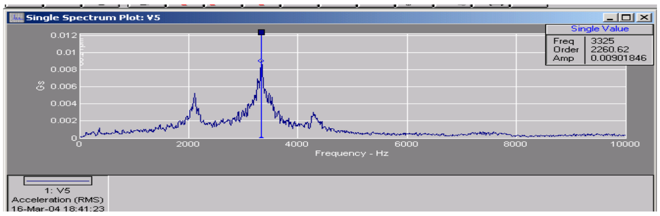
26.10.05; RMS=0, 00194; Q=4, 42



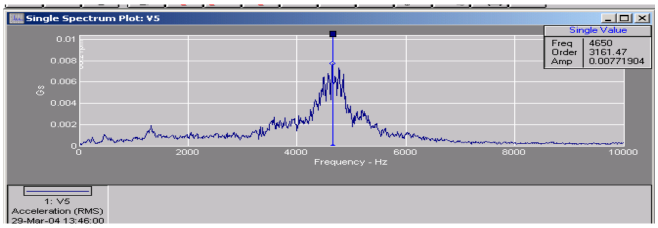
27.04.05; RMS=0, 0359; Q=3



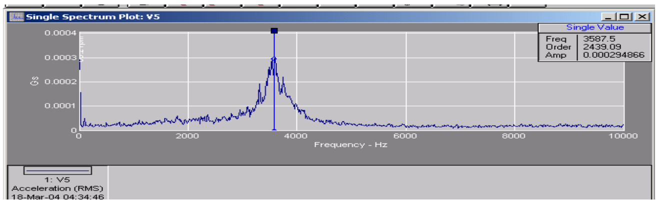
14.05.04; RMS=0,00136;Q=2,9



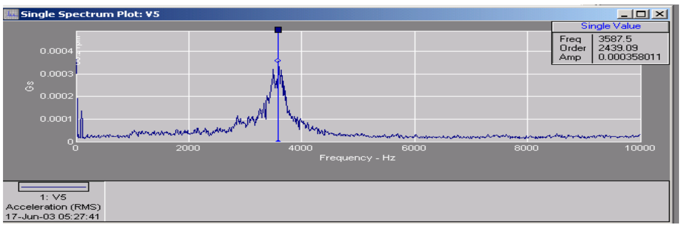
01.04.04;RMS=0,0214 Q=4,9



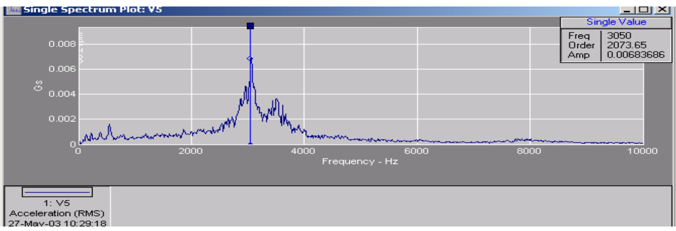
29.03.04;RMS=0,04;Q=6,5



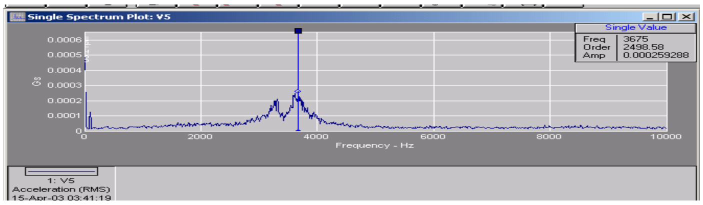
18.03.04;RMS=0,00136;Q=7



17.06.03;RMS=0,0015;Q=9,



27.05.03;RMS=0,0265;Q=4,47



15.04.03;RMS=0,00134;Q=6,4

Figure 7. Response spectraV5 development from15.04.03 till 22.03.0615.04.03-silence; 27.05.03-HA 2, 3, 6, 7, 8, 9 worked; 17.06.03-silence; 18.03.04-silence (night); 29.03.04- strong motion; 01.04.04 worked all HA+ three HA overflow; 14.05.04-silence (night); 27.04.05-worked all HA; 26.10.05-silence (daytime); 22.03.06-silence. For example strong motion response in 29.03.04 RMS=0, 04; **Q=6**, 5, after day 01.04.04; RMS=0,0214 **Q=4,9,**but the mesurements14.05.04;RMS=0,00136; . show **Q=2,9,** and the energy carried frequansy max.is 3787Hz. Limit pressure in concrete of the investigated base emitted signals of AE on frequencies up to 4000 Hz. If AE occurs on higher frequencies stress fault by means of a crack order slide will follow

3 Equipment.

The following equipment was used during the work: 8 accelerometers manufactured by Wilcoxon Research, a SONY 8-channel digital data recorder, type PC208A, an 8-channel data analysis software PCscan MKII and a specialised 8-channel spectrum analysis programme. In some cases, a one-channel data collector-analyser CMVA55 and vibration sensor by SKF Condition Monitoring were used, allowing carrying out the signal analyses in situ.

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