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Geospatial mapping of shear wave velocity of soil of Navi Mumbai by using MASW in GIS platform

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Abstract- In this paper, the shear wave velocity of soil is determined by using SPT " N value" and Vs available correlations developed by various researchers is used as well the procedure for measuring shear velocity at site using multichannel analysis of shear waves (MASW) is explained. This method conducted on site gives the average shear wave velocity at the site for monitoring seismic analysis which helps in site characterization of the ground. This method also aids in comparing the time required to perform the test at ground with respect to its cost. Using GIS as a tool will be helpful in future to find soil properties and earthquake zones for site characterization. The GIS technology is used to assist decision makers by indicating various alternatives in development and conservation planning and modeling the potential outcomes of series of scenarios.

Keywords- Shear wave velocity, multichannel analysis, MASW, Seismic analysis, Site characterization, GIS

I. INTRODUCTION

Multi-channel analysis of surface waves (MASW) is a seismic exploration method evaluating ground stiffness in 1-D, 2-D, and 3-D formats for various types of geotechnical engineering projects. Since its first introduction in the late 1990s, it has been utilized by many practitioners and researched by many investigators worldwide.

First introduced in Geophysics by (Park et. al, 1999), the multichannel analysis of surface waves (MASW) method is one of the seismic survey methods evaluating the elastic condition (stiffness) of the ground for geotechnical engineering purposes. MASW first measures seismic surface waves generated from various types of seismic sources such as sledge hammer analyzes the propagation velocities of those surface waves, and then finally deduces shear-wave velocity variations below the surveyed area that is most responsible for the analyzed propagation velocity pattern of surface waves. Shear-wave velocity is one of the elastic constants and closely related to Young's modulus. Under most circumstances, it is a direct indicator of the ground strength (stiffness) and therefore commonly used to derive load-bearing capacity. After a relatively simple procedure, final information is provided in 1-D, 2-D, and 3-D formats. In comparison to a conventional drilling approach, it is fully implemented on the ground surface (non-invasive), covers the subsurface continuously in a manner similar to ground-penetrating radar (GPR), and provides more complete coverage.

The past seismic events throughout Indian sub- continent have made engineers review their analysis and design approaches seriously. Strong motions locally observed at specific site induced by large earthquake are well known as the site effect caused by weakness in physical properties of superficial soft sediments. A review of historical as well as recent earthquake activity in peninsular India indicated that different parts of the peninsular region are characterized by a low to moderate level of seismic activity. But it is only in recent decades that occurrences of some large and damaging earthquakes has caused concern, which led to study of peninsular seismicity in greater detail. The several earthquake has experienced in Mumbai and Navi Mumbai such as (Airoli area, Navi Mumbai, *Mw*=2.9 on 16 Nov 2001), (Ambernath, Thane *Mw*= 3.7 on 14 June 2005), the most destructive earthquake in Mumbai was on 26 may 1618 which has 2000 fatalities because its intensity of earthquake was 9. Mumbai falls in zone III in the seismic zoning map of India where the intensity VII or VIII from the regional large earthquake or local earthquake of magnitude 6 can expected this can damage single or multi-storied building.

The first documented multichannel approach for surface-wave analysis goes back to early 80s when investigators in Netherlands used a 24-channel acquisition system to deduce shear-wave velocity structure of tidal flats by analyzing recorded surface waves. It first showed the scientific validity of the multichannel approach in surface wave dispersion analysis and, in this regard, the study can be regarded as a feasibility test of the approach for routine use in the future. A subsequent boom in surface wave applications using the MASW method for various types of geotechnical engineering projects has been observed worldwide since that time.

II. METHODOLOGY

The common procedure for (1-D, 2-D, and 3-D) a MASW survey usually consists of three steps: Data Acquisition---acquiring multichannel field records (commonly called shot gathers in conventional seismic exploration)

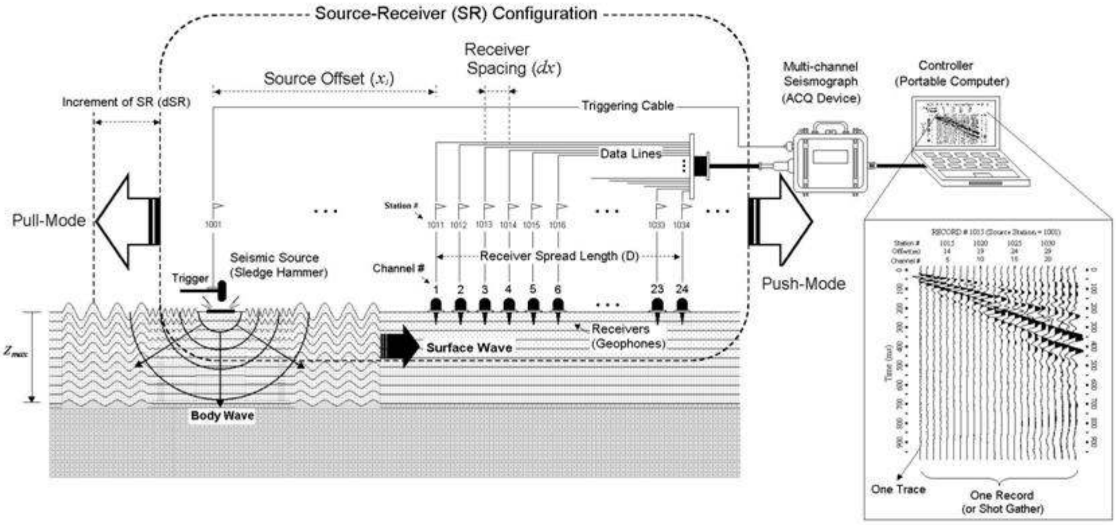

Fig.1: Source- Receiver Configuration of MASW survey

Maximum investigation depth will be determined by the longest wavelength of surface waves used for the analysis. Longest wave length is then governed by the impact power of the seismic source, which can be a controlled type like a sledge hammer in an active survey (or a car moving over a road bump in the case of roadside passive survey). In general, a longer wave length is achieved with a greater impact power. A fairly heavy sledge hammer (e.g., 20 lb) will be a good choice, although other more-sophisticated sources that can deliver more impact power into ground (e.g., a weight drop) can be an advantage over a sledge hammer because of its potential to generate lower (longer) frequencies (wavelengths) of surface waves. The gain from using these other sources is often not enough to warrant cost of the equipment and inconvenience in field operation unless they are carefully designed and built. For example, a mere increase of impact power not accompanied by a careful consideration of energy coupling mechanism many not achieve the goal. Using an impact plate (also called base plate) will help the source impact point intrude less into soil. A detailed study on the role of the base plate in surface wave generation has not yet been undertaken and needs to be done in the near future. Recently, it has been reported that a non-metallic plate (e.g., a firm rubber plate) can generate noticeably stronger energy at the lower frequency part of surface waves (e.g., < 10 Hz) than a conventional metallic plate. This seems related to the speculation that car tire may act as an effective shock-absorber that releases impact power gradually, resulting in a larger-scale deformation of surface around the source point by avoiding permanent (plastic) deformation caused by an abrupt release of impact power. For unusually shallow investigation, a relatively light source has to be used so that the dominant frequency can be shifted.

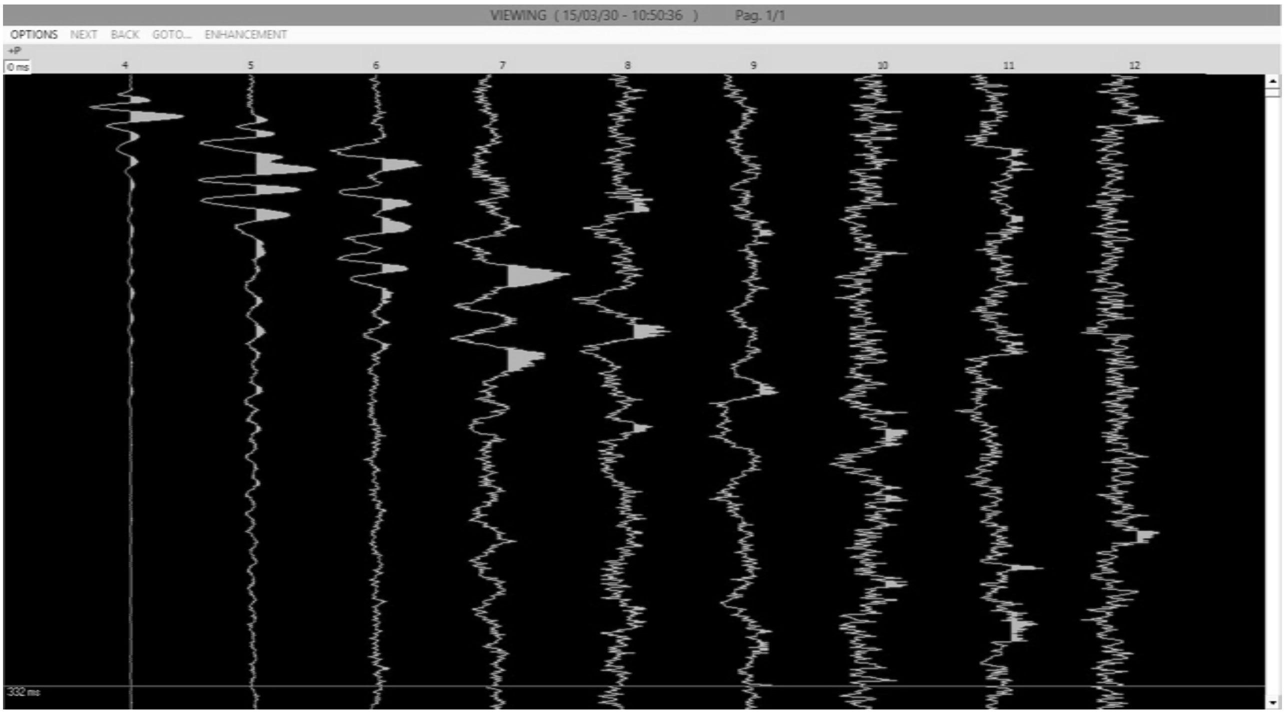

Fig. 2: MASW wave pattern measured on ground using 9 geophones

III. GIS ROLE IN SITE CHARACTERIZATION

Current practice in the characterization of subsurface conditions usually involves the interpretation of data from laboratory and in-situ tests using deterministic analysis methods.

These results are kept in file formats while work is going on for references as the work is completed; these files are not stored properly & that data is lost. This is a common problem that occurs in most of the construction industry due to that whenever new construction will come near that site area it is difficult to find out the subsurface condition of that area because of negligence of handling the geotechnical investigation report as result the new site investigation done which is loss of time and money. For saving money as well as time today's many industries are using GIS technology which is having capability of capturing, storing and analysing and displaying geographically referenced information. Nowadays most are using computers and its minutes click to get the any information regarding their subject. In GIS, map of site is mapped and site investigation data is entered in data sheet which will helpful to urban planner and designer to find out particular ground subsurface profile within in minute. This information helps to design the Earthquake resistant structure which can save the damage of property and human loss due to earthquake.

Table 1: Optimum field parameters for MASW surveys for most common soils

Receiver (Hz) Maximum	Max Depth (m)	Min Offset (m)	Offset (m)	Receiver Spacing (m)
4.5	50	10	100	1
10	30	10	100	1
40	15	10	100	1

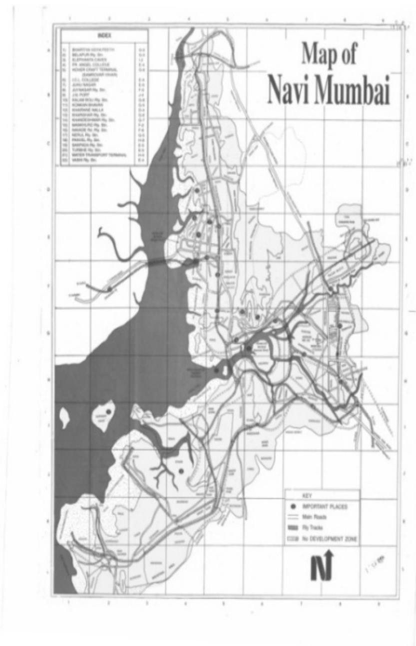

Fig. 2: Navi Mumbai Map

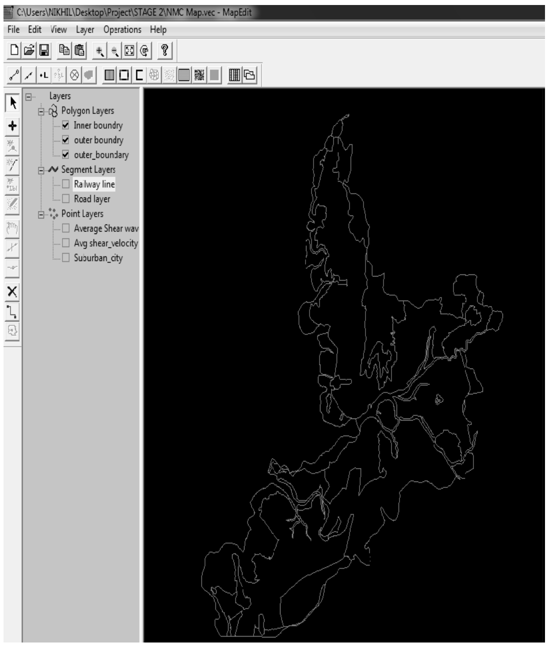

Fig. 3: Digitized Navi Mumbai

Table 2: Average Shear Wave Velocity of Navi Mumbai determined using SPT "N" Value and Vs correlations [2]

Sr. No.	Area	Avg. Shear wave Velocity	Class	Parameters according to NEHRP provisions	Description of soil according to NEHRP provisions
1	Vashi	148	E	<180	Soft soil
2	Kopar Khairane	262	D	180-360	Stiff soil
3	Ghansoli	132	E	<180	Soft soil
4	Airoli	344	E	180-360	Stiff soil
5	Sanpada	342	E	180-360	Stiff soil
6	Nerul	345	E	180-360	Stiff soil
7	CBD Belapur	347	E	180-360	Stiff soil

Table 3: Data Acquisition Parameters:

Sr. no.	For Soft Soils	For Stiff soils
Acquisition Time:	1024 ms	1024 ms
Sampling Time:	250	500
Display:	Area Variable	Area Variable
Channel Selection:	1-12	1-12
Auto Trace Size:	On	On
Gain Settings:	10	10

IV.CONCLUSION

Shear wave velocity is important parameter in site classification according to NEHRP (National earthquake hazard reduction programme), 2000 and dynamic properties of soil. It has noticed that average shear wave velocity of Navi Mumbai is in range 130 to 340 m/s which indicates Navi Mumbai come under the site class E and D, it means there is soft soil and stiff soil is present as per NEHRP site classification, Navi Mumbai city may experience strongest amplification of earthquake due to its soil condition. By knowing the measured shear wave velocity at site, the time required & costs associated with the tests can be ascertained. The Average shear velocity of Navi Mumbai is mapped and data base is created in GIS Gramm++ software ,it has found that this data base will helpful to designer ,practitioners for preliminary seismic hazard ,and soil condition and ground water level which save the time and money to finding ground properties of Navi Mumbai city.

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