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Application of GPSeismic in Seismic Surveys in Palar Basin

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Summary

In oil industry all the seismic crew use Global Navigational Satellite System (GNSS) for staking / positioning of receiver and shot profile pickets. Due to high challenges faced in seismic data acquisition, the present day acquisition geometry demand increased no. of channels, in the order of 2000 to 6000 and need very precise positioning for the accuracy of 1cm in horizontal and 5cm in vertical.

The volume of topographic survey required for seismic data acquisition is huge inspite of having adequate number of GNSS receivers with the crews. Further, due to the survey areas located in forest covered areas where the satellite positioning ambiguity cannot be resolved, conventional survey methods are also required to be used for staking the seismic profiles. The QC of the data obtained by various methods need to be integrated for precise positioning.

Quality control on GNSS, RTK data and the performance of GNSS receivers is a must to ensure data integrity. Manual QC on GNSS data will be very tedious and cumbersome and may not be feasible on daily huge volume of data. An attempt has been made for the automated QC of GNSS data in Palar Basin, India using advanced software like GPSeismic .

The parameters used methodology and advantages of automated QC on GNSS RTK data using the GP Seismic Software are discussed in the paper.

Introduction

Geophysical exploration methods and in particular seismic surveys are commonly used for discovering new oil and gas fields. Land seismic surveys require tremendous amount of equipment and workforce. They also depend heavily on the surface terrain, i.e. land use and land cover, relief and presence of man-made features such as build-up areas, roads, bridges etc.

Seismic operations consist of several stages, such as planning, field scouting, survey design and project execution. GPS is a satellite-based system that provides accurate location and timing information 24 hours a day.

There are currently two "public" GPS systems one is NAVSTAR system and another one is GLONASS system. The NAVSTAR system is owned by the United States and managed by the Department of Defense. The GLONASS system is owned by Russian Federation and managed by "Coordinational Scientific Information Center".

Today users can benefit from a combined GNSS satellite constellation comprising of 30 GPS and 21 GLONASS satellites. The combined solution was able to reduce the time-to-fix ambiguities and increase the availability of precise position even when sufficient GPS satellites are not available.

GPS adopts WGS84 as reference frame and time scale called GPS time. GLONASS adopts PZ-90 as reference frame and works with GLONASS time. Hence quality control of combined data of GPS+ GLONASS becomes very significant. During data acquisition the GNSS data is normally acquired in two methods, i.e. Static / Fast static and Real Time

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Kinematic (RTK), depending on the application and requirements. As for as seismic data acquisition is concerned Static method is used for establishing precise GPS network and control stations and RTK mode of surveying is used for precise staking & obtaining positions of Easting, Northing and Elevation in real time. Hence GNSS raw data observed on both static and RTK mode needs through quality control and analysis, to ensure data integrity.

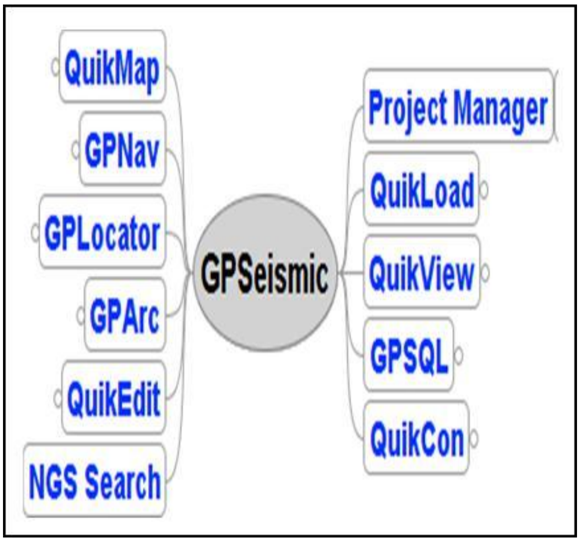
Quality testing of static raw data, in Receiver Independent Exchange Format (RINEX) format can be carried out using exclusive quality control software like Leica GNSS QC, for various tests specifically receiver clock offsets, antenna offsets, multipath etc. Quality control of RTK data in native format can be carried out using GPSeismic software. Customized automatic quality control on various parameters like PDOP, HDOP, VDOP, Number of Satellite, Number of Epochs, Variance, Horizontal and Vertical Precision, Standard deviation, Reliability etc. can also be done.

Quality control of GNSS, Real Time Kinematic (RTK) Data.

A minimum of five common satellites with good geometry is required for RTK surveying and in order to obtain cm-level accuracy with differential kinematic GNSS positioning, the carrier phase ambiguities in the measurement update have to be resolved over the initial baseline before the GNSS receiver goes into the kinematic mode and phase lock should be maintained on a minimum number of 4satellites thereafter in a good geometry.

However, during the period of kinematic GPS surveys, cycle slips on all or most of the available satellites may occur due to carrier signal obstruction by objects or other tracking problems. In such a situation, the initially resolved carrier phase ambiguities N of all the corresponding satellites, which are held fixed initially, will change by an arbitrary integer number of cycles. Therefore, the new carrier phase ambiguities N of all or most of the satellites have to be resolved again or re-initialized during the kinematic surveying mode in order to maintain the cm-level positioning accuracy. If RTK initialization takes place under circumstances of high RMS, then the elevations of all stations surveyed after that initialization will have an error of more than 1 m approximately. Mostly this error in elevation goes unnoticed, if not checked properly. Cycle slips and re- initialization with high RMS is often encountered in the highly vegetated areas like KG-PG, Cauvery and Palar Basins in Indian context.

GNSS Data Quality Analysis by using GPSeismic



Software Overview

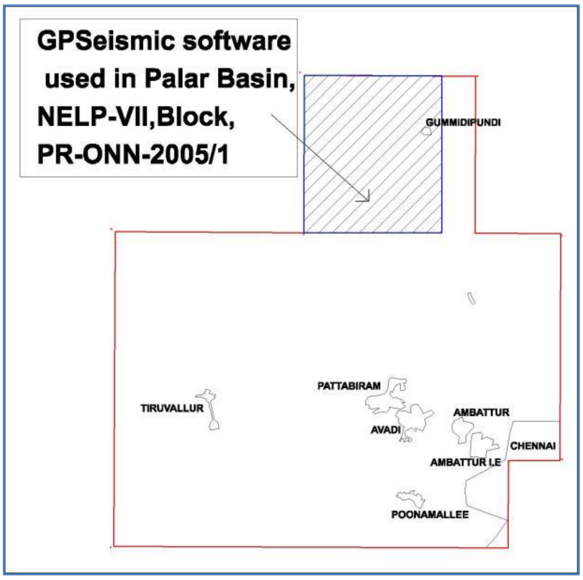
GPSeismic® started as two applications, QuikLoad and QuikView, in support of the Trimble real-time GPS stakeout system. QuikLoad imported or generated preplots in grid coordinates, converted these coordinates to WGS84 geographic coordinates, and then allowed the user to create stakeout files for the Trimble system. QuikView converted the stakeout files back to grid coordinates. Both programs allowed these functions to be conducted graphically.

GPSeismic now includes support for numerous GPS, inertial and conventional systems and contains an application called GPSQL for data management. An MDB database serves as the repository of all surveyed points and associated quality control indicators.

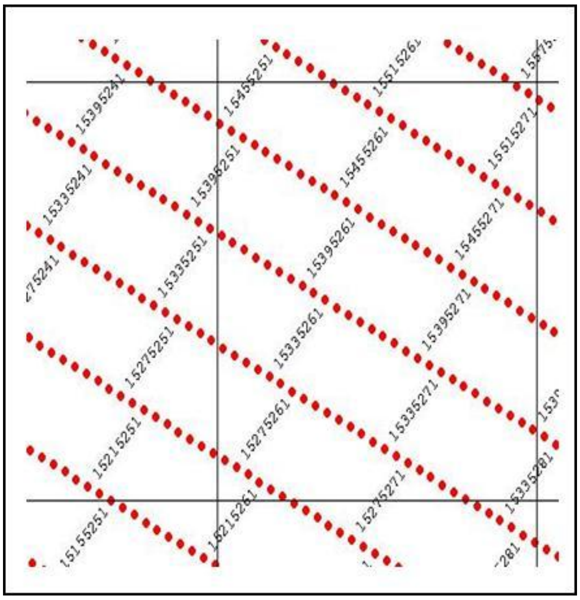
There is often the need to modify preplots in some manner. Perhaps there are exclusion zones that require that points be deleted or moved. QuikMap is a powerful application that allows the user to make these modifications and much more. So it might very well be that for a particular project, QuikMap is first used to make the required preplot modifications, and these modified preplots are then imported into QuikLoad.

Field Application

The above mentioned GPSeismic software being used during the seismic surveys in Palar Basin, NELP-VII, Block-PR- ONN-2005/1 during the current field season 2010-11.

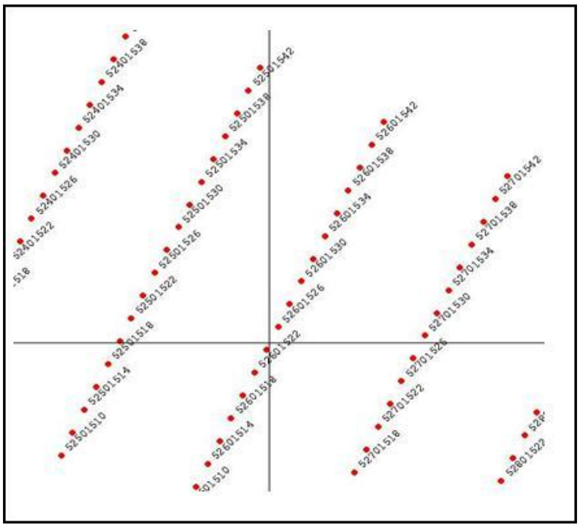


Index Map, Fig.1.



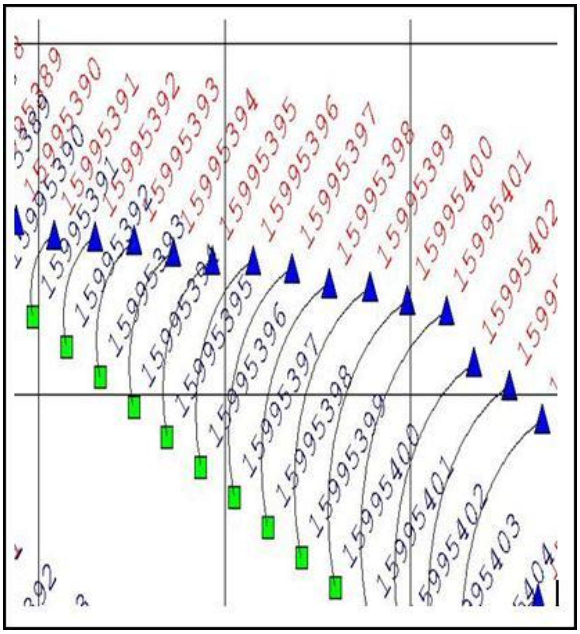
Receiver Picket Pre-Plot, Fig.2.

The above Fig.2. shows the pre-plots of receiver line of 3D survey campaign.



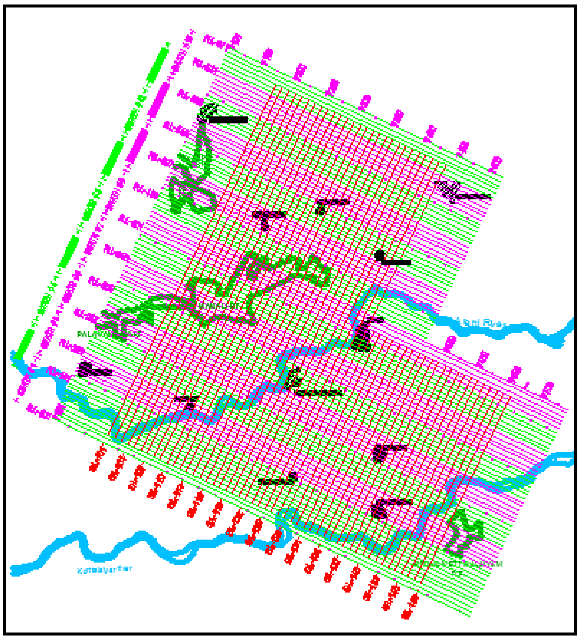
Source Picket Pre-Plot, Fig.3.

The above Fig.3. shows the pre-plots of shot line of 3D survey campaign.

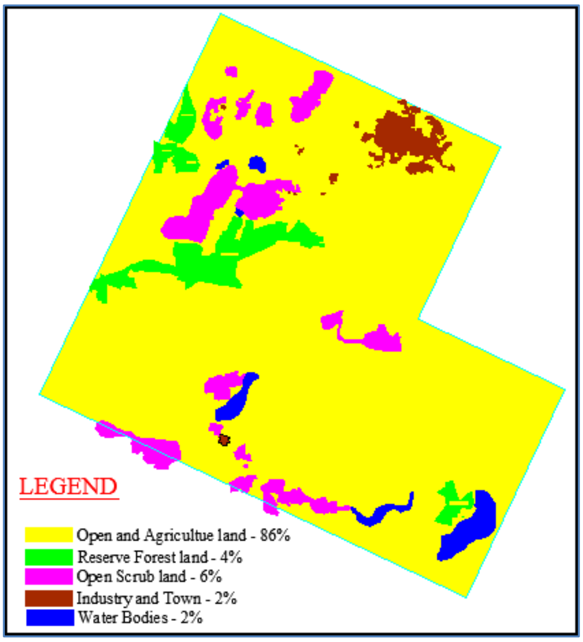


Receiver Picket Post Plot, Fig.4.

In Fig.4.green colour indicates proposed location and blue colour indicates actual staked offset locations.

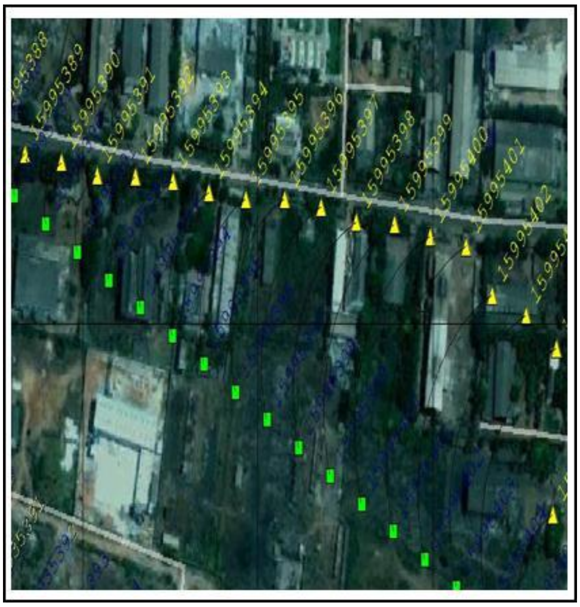


Location Map, Fig.5.



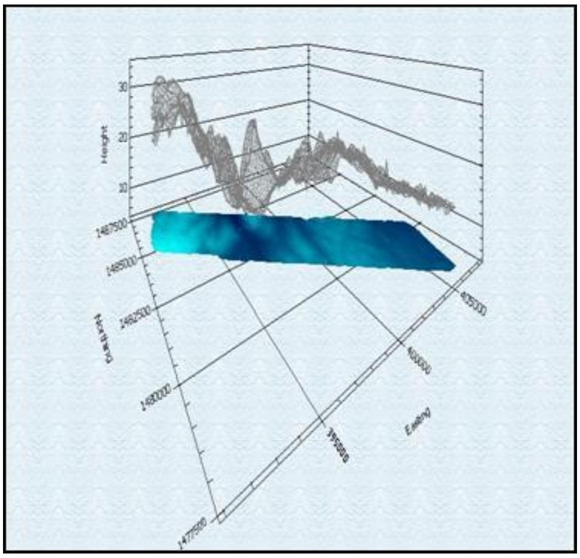
Logistic Map, Fig.6.

The populated town and industrial area is at the southeast corner of the survey area.(Fig.6.). The reserve forest area like Plavakkam and Manali are situated at Northwest part of the operation area (Fig.6.). Due to industry buildings and reserve forest and safety distances required to be maintained, the receiver and source points were relocated from the pre- plot positions. The staked locations were thoroughly analyzed by GPSeimic with Google Images.



Google Image, Fig.7.

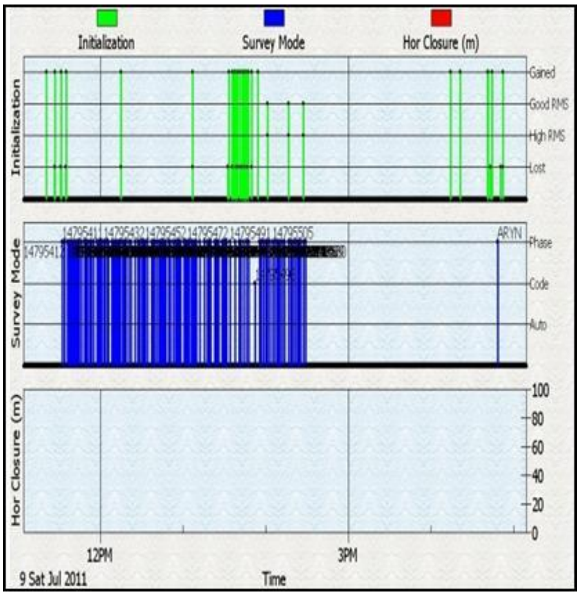
The above Fig.7. shows the staked pickets with background google images, this will ensure to check the staked offset picket positions in real time.



Elevation Surface Model, Fig.8.

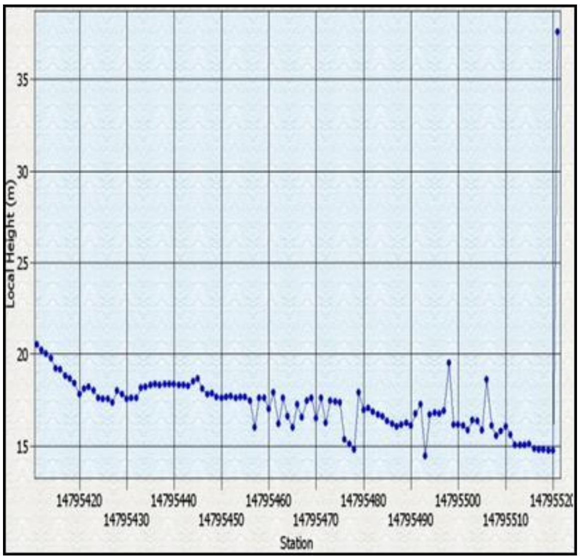
By using GPSeismic with the help of downloaded swath data contour and surface models are created Fig.8.

The downloaded RTK raw data observations gives complete information on station ID, track, bin, code (receiver/source) WGS84 Latitude, Longitude and WGS84 Ellipsoid height, Survey mode (Autonomous, Code, Float or Phase), instrument height, offset information on coordinate difference between theoretical (pre-plot) and actual locations (post-plot), quality information on horizontal and vertical precision, number of satellites tracked, PDOP, HDOP, VDOP & GDOP values, observation time, baseline length, base station details, occupation time, Initialization block, unit variance etc, for every single point occupation. The reliability analysis and statistical testing on various parameters can then be carried out using GPSQL, an application tool for management of data containing in a Microsoft Access Database.



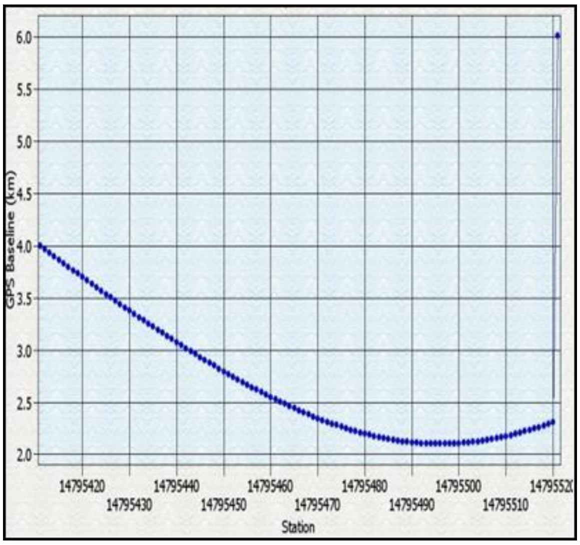
GPS Initialization Analysis, Fig.9.

Analysis on RTK Initialization, the above Fig.9. shows that re-initialization has taken place almost 29 times for staking of 110 pickets for the distance of about 4.5kms for the whole day field operation.



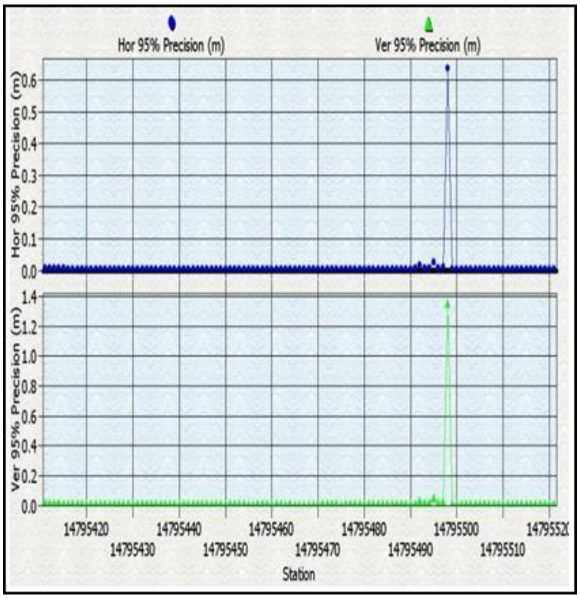
Elevation Chart, Fig.10.

By generating an elevation graph Fig.10.We can cross check elevation spikes with the actual topographical terrain. If the re-initialization takes place under high RMS, then elevation values have to be cross checked by taking a check shot in field.



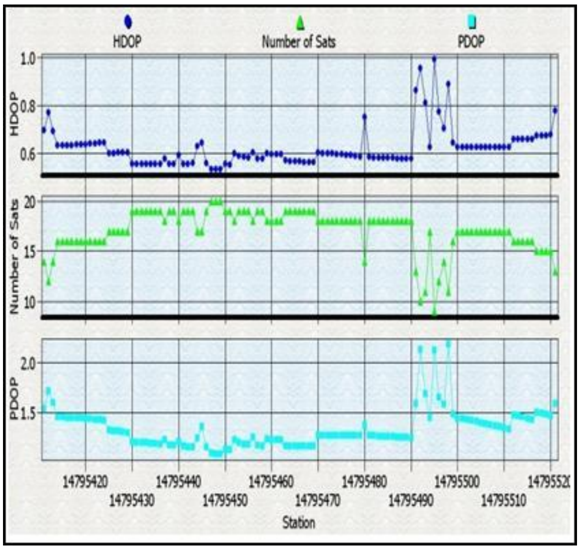
Baseline Chart, Fig.11.

Baseline chart Fig.11. can helps to analyze the distance between base and rover station.



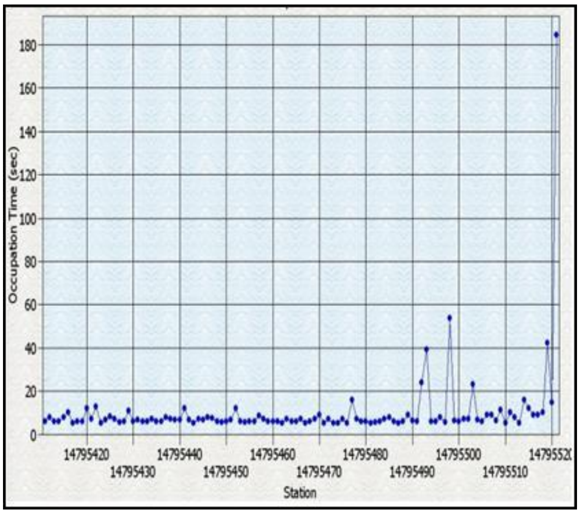
Precision Quality Chart, Fig.12.

The above Fig.12. shows the 95 % precision quality for both Horizontal & Vertical positioning, Queries can be made on combination of various parameters (example for identifying bad shots, Select (`Survey Mode (value)`=Code) And (PDOP`>4 or Number of Satellites`<5) as per the quality requirements. Quality reports / charts can be generated for auditing and output of data can be given in various formats.



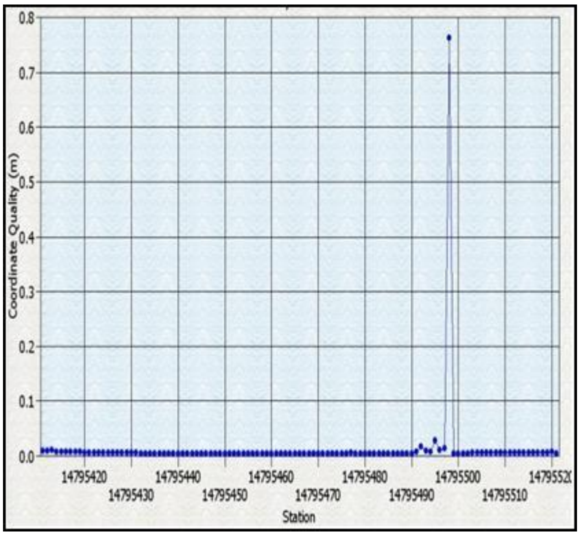
HDOP,PDOP and Satellite Chart, Fig.13.

The next important parameter is HDOP and PDOP Fig.13. The data quality, particularly vertical positioning depends on PDOP values and horizontal positioning depends on HDOP. It is advisable to stake locations by having less than 4 PDOP value as threshold limit. It is interesting to note from Fig.12. that the PDOP and HDOP values increases, with decrease in number of satellites available. More number of satellites, will always helps in reducing the time-to-fix ambiguity.



Observation Time Chart, Fig.14.

Fig.13. shows the observation time plot. It is better to have a minimum of 5 epoch data, though 1 epoch RTK data is also theoretically acceptable.



Coordinate Quality Chart, Fig.15.

Surveyor can analyze quality of coordinate by generating the coordinate quality map Fig.15.

Conclusion

Manual Quality control on GNSS-RTK data and monitoring performance of GNSS receivers is not be feasible on daily basis due to huge volume of data.

However, the application of software like GP Seismic during seismic survey for automated QC of GNSS data in Palar Basin, India during execution has helped in improving quality as well productivity even in thick reserve forest and industrial areas

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Views expressed in this paper are that of the author(s) only and may not necessarily be of ONGC.

References

GNSS QC software (free version) tutorials

GPSeismic software tutorials

Trimble Business Centre tutorials.

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