DIFFERENT INDICES FOR VOLTAGE COLLAPSE PREDICTION IN POWER SYSTEM

[1]Sumit Kumar, [2]Anurag S D Rai, [3]Reeta Pawar, [4]Anjana Tripathi
[1]Research Scholar Mtech. Power Systems, [2,4]Assistant Professor, [3]Associate Professor
[1,2,3] Department of Electrical and Electronics Engineering,
[1,2,3,4] AISECT University, Bhopal-Chiklod Road, Raisen-464993 (M.P)

***Abstract*— As the systems power-transmission complexity were increasing in present perspective due to this measurement is becoming complex due to higher order of complexity. Voltage collapse of the system is one of the major fault which leads to the blackouts. If the prediction of this type of fault and any other relative parameters variation by the help of Indices in the system lead to prediction of the variation and preparing for the preventive measures. In this work IEEE 6, 14 and 30 bus system are utilized for the contingency of line outage and several operating conditions. In this work L-Index and its utility is taken in account for numerical calculations and transient process.**

I. INTRODUCTION

In present scenario as the power in the pool is becoming more transmission system are operating in security limits. Mostly stability limits are associated to transient and thermal limits of the system. A power system is voltage stable if it maintain the value to voltage to the pre-disturbance value, similarly it became voltage instable if it is incapable in maintaining pre-disturbance value. As the voltage security of system is V-Q sensitive which helps in determining reactive power demand if less then it system tends to instability and we had to manage the contingency by supply of additional power.

II. VOLTAGE INSTABILITY

In power systems, due to inability of managing system contingency, leads to many unwanted conditions as brownouts, blackouts and security threats. As study of Mechanism for instability of voltage in system, along with instability of voltage Proximity leads to two methods of studying Voltage instability. Load Flow Feasibility (LFF) and Steady State Stability (SSS) are two static methodology.

"Instability of Voltage is majorly a local phenomenon. The objective in research here is to identify faulty location along with instability in voltage identifying the weak bus".

Which are as follows:

- PV curves are utilized in under stressed transmission system findings.
- PV curves are not assigned for weak bus identification.
- PV curve analysis is utility is dependent on application.

III. COLLAPSE OF VOLTAGE IN SYSTEMS

As in power pool; power were regulated by active and reactive flow of power. When system is unable to regulate the desired voltage contingencies occurred in system.

Typical scenario for collapse in voltage are as follows:

- Due to abnormal operation of large machines and their operating parameters few of them are not in contribution.
- As additional reactive power demand create security violation with reduction of voltage along with other operation limits.

1. Voltage stability analysis

There can be various ways to analyze voltage stability, one of them discussed here.

- PV and QV curves.

2. PV-QV curve

PV curves: The PV curves are utilized in voltage stability analysis. Theses curves determine Mega Watt distance of the system to voltage collapse center from control center.

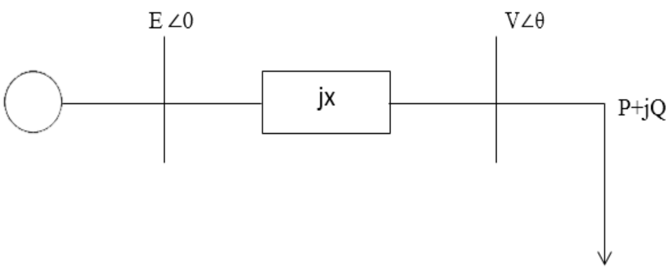

Figure 1. Two-bus system

$$P = -\frac{EV}{X}\sin\theta \quad (1)$$

$$Q = -\frac{V^2}{X} + \frac{EV}{X}\cos\theta \quad (2)$$

$$V = \sqrt{\frac{E^2}{2} - QX \pm \sqrt{\frac{E^2}{4} - X^2P^2 - XE^2Q}} \qquad (3)$$

Where P is the total load in an area and V is the voltage of critical bus. A two bus system. Where, active and reactive power respectively are P and Q, consumed by the load, voltage of load bus as V and angle between E and V is θ.

IV. L_{MN} INDEX FOR STABILITY OF LINE

L_{mn} represents Index for stability in power line to realize single line diagram, Moghavvemi M. along with Omar [4]. As the proximity of voltage collapse in system lead to security contingencies.

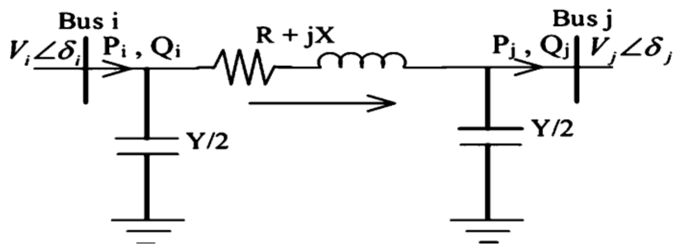

Figure 2. Typical one-line diagram of transmission line.

From power flow equation,

$$S_i = \frac{|V_i||V_j|}{Z}\angle(\theta - \delta_i + \delta_j) - \frac{|V_j|^2}{Z}\angle\theta \qquad (1)$$

Separating the above equation in real and reactive power then,

$$P_j = \frac{V_iV_j}{Z}\cos(\theta - \delta_i + \delta_j) + \frac{V_j^2}{Z}\cos\theta \qquad (2)$$

$$Q_j = \frac{V_iV_j}{Z}\sin(\theta - \delta_i + \delta_j) + \frac{V_j^2}{Z}\sin\theta \qquad (3)$$

Where, $\delta = \delta_i - \delta_j$ and now solving for line voltage as we

$$V_j = \frac{V_i\sin(\theta-\delta) \pm \{[V_i\sin(\theta-\delta)]^2 - 4ZQ_j\sin\theta\}^{0.5}}{2\sin\theta} \qquad (4)$$

Substitute $Z\sin\theta = X$

$$[V_i\sin\theta]^2 - 4Q_jX \geq 0 \qquad (5)$$

The index of stability for line can be formulated as [4]:

$$L_{mn} = \frac{4XQ_j}{[V_i\sin(\theta-\delta)]^2} \leq 1 \qquad (6)$$

V. LQP FACTOR OF STABILITY FOR POWER LINE

As given in reference [4] it is defined as:

$$LQP = 4\left(\frac{X}{V_i^2}\right)\left(\frac{XP_i^2}{V_i^2} + Q_j\right) \qquad (7)$$

VI. RESULT

For 6 bus system

(All calculations are on 100 MVA base)

Table 1 L index at different loading conditions (6 bus system)

Bus no.	*Voltage stability L index*					
	Base load	*140%*	*180%*	*220%*	*260%*	*peak load*
3	0.1245	0.1821	0.2477	0.3264	0.4299	0.6643
5	0.1031	0.1497	0.2018	0.2618	0.3347	0.4847
6	0.0995	0.1426	0.1922	0.2511	0.3259	0.4809
4	0.0912	0.1335	0.1816	0.239	0.3136	0.4761

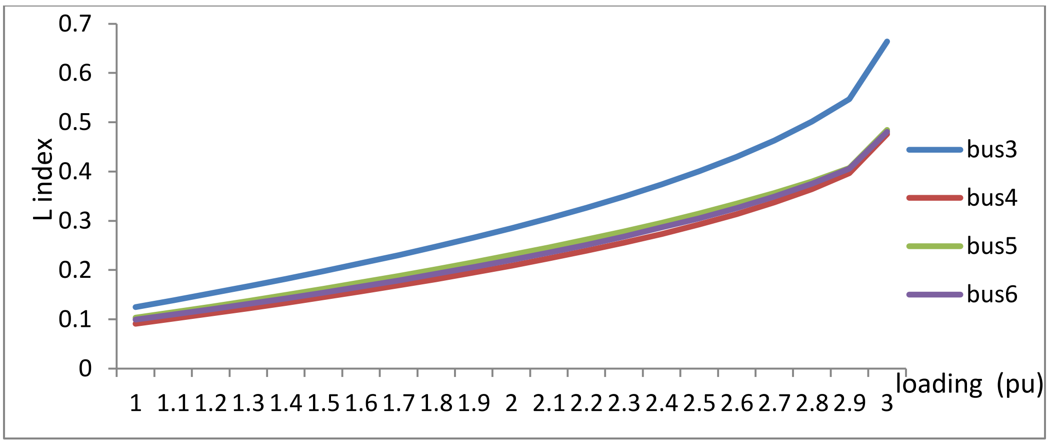

Figure 3 L index curve (6 bus system)

Table 2 Minimum eigenvalues of reduced Jacobean at different loading conditions (6 bus system)

% Loading	Minimum eigenvalue
100	1.8689
110	1.8541
120	1.8375
130	1.8191
140	1.7986
150	1.776
160	1.7511
170	1.7236
180	1.6932
190	1.6597
200	1.6226
210	1.5815
220	1.5356
230	1.4843
240	1.4265
250	1.3606
260	1.2846
270	1.1954
280	1.0876
290	0.952
300	0.6379

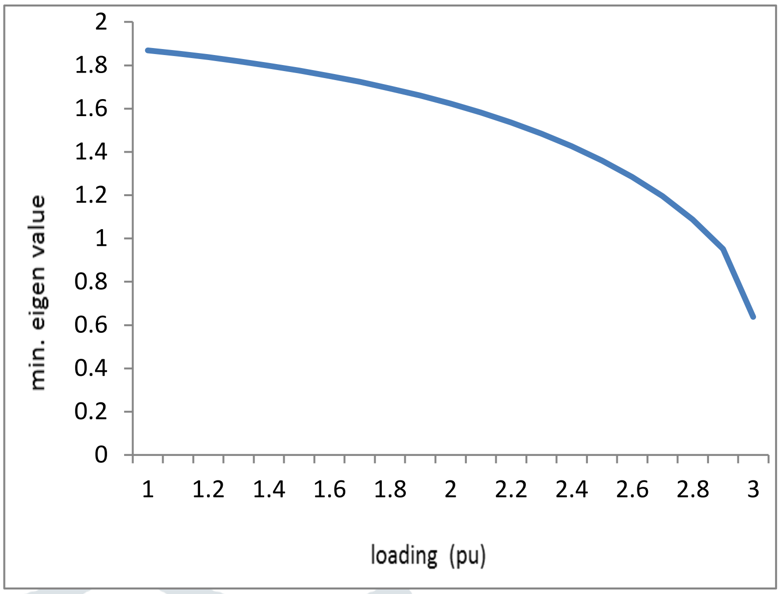

Figure 4 Minimum eigenvalue curve for reduced Jacobean matrix (6 bus system)

VII. CONCLUSION

This research work let us know about indexing in the system and comparing the performance of stability. L-Index and traditional counterpart Jacobean for IEEE standard Bus system had to be taken care for contingency analysis of the system. As system parametric variation and its prediction and correction by the algorithms are done, improvised version helps in making system more efficient.

VIII. REFERENCE

[1] S. Pérez-Londoño, L.F. Rodríguez, G. Olivar b "A Simplified Voltage Stability Index (SVSI)", 'Elsevier' Electrical Power and Energy Systems (2014).

[2] Jia Hongjie, Yu Xiaodan, Yu Yixin, "An improved voltage stability index and its application", 'Elseviar' Electrical Power and Energy Systems (2005).

[3] C.A. Belhadj, M.A. Abido, "An Optimized Fast Voltage Stability Indicator", Electrical Enginnering Department (1999).

[4] Rajiv Tiwari, K.R. Niazi, Vikas Gupta, "Line collapse proximity index for prediction of voltage collapse in power systems", 'Elseviar' Electrical Power and Energy Systems (2012).

[5] Sandro Corsi, Member, IEEE, and Glauco N. Taranto, Senior Member, IEEE, "A Real-Time Voltage Instability Identification Algorithm Based on Local Phasor Measurements" (2008).

[6] Claudia Reis and F.P. Maciel Barbosa "Assessment of voltage stability of Electrical power systems: A simulation survey" 2007.

[7] R Raghunatha, R Ramanujam, K Parthasarathy and D Thukaram, "A new and fast technique for voltage stability analysis of a grid network using system voltage space", 'Elseviar' Electrical Power and Energy Systems, 1998.

[8] Alex Pama, Ghadir Radman, "A new approach for estimating voltage collapse point based on quadratic approximation of PV-curves", 'Elseviar' Electric Power Systems Research, nov. 2008.

[9] Yang Wang, Caisheng Wang, Feng Lin, Wenyuan Li, Le Yi Wang, Junhui Zhao, "A new transfer impedance based system equivalent model for voltage stability analysis", 'Elseviar' Electrical Power and Energy Systems, may 2014.

[10] V. Jayasankara, etal , "Estimation of voltage stability index for power system employing artificial neural network technique and TCSC placement", 'Elseviar' Neurocomputing, aug 2010.

[11] S. Shirisha, etal , "Evaluation of modal analysis voltage stability using Artificial Immune System", 'International Journal of Computer Applications', may 2012.

[12] Anurag S D Rai, Lovesh B Xaxa, Prakhar Singh Bhadoria, Ankita Tiwari, "Topologies of FACTS controllers and their adaptation issues", International Journal of Science and Research, ISSN (Online): 2319-7064, Vol. 04 Issue 5, May 2015.

[13] Anurag S D Rai, "Modeling of Relay by PSCAD/EMTDC for use in Power System Protection Studies", National Seminar on Prospects and Challenges of Electrical Power Industry in India, ISBN 978-93-84743-43-7 © 2015 Bonfring, page no 404-4087, February 11-12, 2015.

[14] K T Chaturvedi, Anurag S D Rai, Bhoopendra Rohit,, "Algorithms for Synchrophasor Enabled Digital Relay", HCTL Open International Journal of Technology Innovations and Research (IJTIR), Volume 21, Issue 1, July 2016, e-ISSN: 2321-1814, ISBN (Print): 978-81-932623-1-3.

[15] Anurag S D Rai, Kamal Shakya, etal, "HVDC Rectifier Station Modelling using PSCAD-EMTDC", HCTL Open International Journal of Technology Innovations and Research (IJTIR), Volume 21, Issue 1, July 2016, e-ISSN: 2321-1814, ISBN (Print): 978-81-932623-1-3.

[16] Anurag S D Rai, C S Rajeshwari, Anjali Potnis, "Voltage fluctuation and regulation improvement through the genetic algorithm based DPFC in a power transmission system", Eduved International Journal ofInterdisciplinary Research, ISSN 2348-6775 (online), Vol. 01 Issue 05 Aug 2014.

[17] Anurag S D Rai, C S Rajeshwari, Anjali Potnis, "Modeling of Distributed Power Flow Controller (DPFC) in MATLAB/Simulink", Eduved International Journal of Interdisciplinary Research, ISSN 2348-6775 (online), and Vol. 01 Issue 06 Sep.2014.
[18] Anurag S D Rai, Shrikant Mishra, etal "Impact of Load Elasticity in Restructured Power System", Eduved International Journal of Interdisciplinary Research, ISSN 2348-6775 (online), Vol. 01 Issue 06 Sep.2014
[19] Anurag S D Rai, etal "Design and analysis of PWM multi-level npc inverter for power quality integration Of wind power into grid", journal of emerging technologies and innovation Research (jetir), volume-04, issue-05,may 2017, issn-2349-5162