TABLE OF CONTENT

PERNYATAAN BEBAS PLAGIASI ..... **iii**
PREFACE ..... **iv**
TABLE OF CONTENT ..... **v**
LIST OF TABLE ..... **viii**
LIST OF FIGURES ..... **x**
ABSTRACT ..... **xix**
INTISARI ..... **xx**
CHAPTER 1 INTRODUCTION **21**
1.1 Background **21**
1.2 Problem Statement **22**
1.3 Objectives **22**
1.4 Limitation **23**
1.5 Benefit **23**
1.6 Research Originality **23**
CHAPTER 2 LITERATURE REVIEW **25**
2.1 Pile-Supported Slab Viaduct (PSSV) as an Elevated Highway and Railway Structure **25**
2.2 Shear Panel Damper **28**
CHAPTER 3 THEORETICAL BACKGROUND **31**
3.1 The minimum seismic design load for railway bridges **31**
3.2 Ground Motion Modelling **33**
3.2.1 Target spectrum 34
3.2.2 Ground motion selection 34
3.2.3 Ground motion modification 35
3.3 Constitutive Model of Materials **35**
3.3.1 Concrete material 35
3.3.2 Prestressed concrete (PC) bar 38
3.4 Dynamic Beam on a Nonlinear Winkler Foundation (BNWF) **39**
3.4.1 p-y material 40
3.4.2 Axial (t-z) soil springs 42

3.4.3 Tip resistance (q-z) soil springs 43
3.5 Fixity depth of pile 45
3.6 Shear panel damper (SPD) basic properties 46
3.7 Seismic evaluation method for PSSV structure 49
3.7.1 Performance level 49
3.7.2 Displacement demand and capacity 50
3.7.3 Damping ratio 51
CHAPTER 4 RESEARCH METHODS 52
4.1 General 52
4.2 Data 54
4.3 Validation of numerical analysis for spun pile element 56
4.3.1 Irawan *et al.* (2018) experiment method 56
4.3.2 Numerical model using OpenSees 57
4.3.2.1 Physical and element properties 57
4.3.2.2 Conditions 58
4.3.2.3 Analysis steps 59
4.3.3 Spun pile section model using Response2000 59
4.3.3.1 Materials properties 59
4.3.3.2 Cross-section definition 62
4.3.3.3 Axial load 64
4.3.4 Numerical model using SAP2000 64
4.3.4.1 Materials definition 64
4.3.4.2 Section definition 65
4.3.4.3 Hinge definition 67
4.3.4.4 Structural modeling 69
4.3.5 Validation and verification results 70
4.3.5.1 Moment-curvature curve comparison 70
4.3.5.2 Pushover and cyclic analysis result 70
4.4 Determining fixity depth of spun pile in sand 76
4.5 Preliminary seismic design of ordinary PSSV structures 78
4.5.1 Structural model and definitions 81
4.5.2 Loads 83
4.5.3 Spun pile capacity check 87

4.6 Ground motion modeling 88
4.6.1 Ground motion selection 88
4.6.2 Ground motion modification 90
4.7 Shear panel damper (SPD) properties 95
4.8 Shear panel damper and steel bracing application in the PSSV structure 96
4.9 Seismic performance investigation method 97
4.9.1 PSSV structural model in STKO 98
4.9.1.1 Physical and element properties 98
4.9.1.2 Conditions 102
4.9.1.3 Analysis steps 103
4.9.2 PSSV structural model in SAP2000 104
CHAPTER 5 RESULT AND DISCUSSION 107
5.1 Modal analysis 107
5.2 Pushover analysis 109
5.3 Cyclic analysis 117
5.4 Nonlinear time history analysis 120
CHAPTER 6 CONCLUSION AND RECOMMENDATION 146
6.1 Conclusion 146
6.2 Recommendation 147
REFERENCES 148
APPENDIX 153
Appendix 1. Spun pile concrete and PC bar material model 153
Appendix 2. Spun pile section data 154
Appendix 3. Nonlinear soil spring properties 156
Appendix 4. Shear panel damper properties 159