Table of Contents

About the cover 3
Table of Contents 4
Rounding off numbers and results 10
Pictures, Figures, Equations and Tables 10
Symbols used in this book 10
A. Introduction 11
B. Why this book 12
C. About this book 13
D. What this book is not 13
E. For who is this book 14
F. Nomenclature 15
G. The coordinate system 37

1 Principle working of the Hydraulic Platform Transporter 56
1.1 What is a platform 57
1.2 Difference between a 3-point and 4-point suspension 58
1.2.1 What exactly happens when “rocking” occurs 58
1.2.1.1 Resonance 59
1.2.1.2 Overload 59
1.2.2 Why do 4-point suspension systems exist 59
1.3 Other suspension systems 60
1.4 What is the stability area 60
1.5 The Center of Gravity (CoG) 62
1.6 The hydraulic platform transporter, naming convention and colour coding 64
1.6.1 Naming convention for valves 64
1.6.2 Color coding hydraulic lines 66
1.6.3 Naming convention for transporter direction and suspension groups 66
1.6.3.1 Transporter direction 67
1.6.3.2 Suspension groups 70
1.7 Transporter suspension system, example 1-a 74
1.7.1 Transporter stability area, example 1-b (graphical) 75
1.7.2 Transporter stability area, example 1-c (mathematical) 76
1.8 Transporter suspension system, example 2-a 81
1.8.1 Transporter stability area, example 2-b (graphical) 82
1.8.2 Transporter stability area, example 2-c (mathematical) 83
1.9 Transporter suspension system, example 3-a 86
1.9.1 Transporter stability area, example 3-b (graphical) 87
1.9.2 Transporter stability area, example 3-c (mathematical) 88
1.10 Transporter suspension system, example 4-a 92
1.10.1 Transporter stability area, example 4-b (graphical) 93
1.10.2 Transporter stability area, example 4-c (mathematical) 94
1.11 Transporter suspension system, example 5-a 98
1.11.1 Transporter stability area, example 5-b (graphical) 100
1.11.2 Transporter stability area, example 5-c (mathematical) 101

1.12 Transporter suspension system, example 6-a 104
1.12.1 Transporter stability area, example 6-b (graphical) 106
1.12.2 Transporter stability area, example 6-c (mathematical) 107
1.13 Transporter suspension system, example 7-a 111
1.13.1 Transporter stability area, example 7-b (mathematical) 112
1.14 The aftermath 115
2 Stability Area and Transporter CoG, where are they located 117
2.1 Stability Area of the pendulum axle 117
2.2 Stability Area of the fusee axle 119
2.3 Stability Area, when on a cambered road 120
2.4 What if the stability area is assumed at the transporter deck (pendulum axle) 122
2.5 What if the stability area is assumed at the transporter grade (pendulum axle) 123
2.6 Transporter CoG 124
2.7 The aftermath 126
3 Center of Gravity kinetics 128
3.1 Center of Gravity kinetics, example 1-a 128
3.2 Center of Gravity kinetics, example 1-b (graphical) 129
3.3 Center of Gravity kinetics, example 1-c (mathematical) 130
3.3.1 Express both lines as an equation (ALPHA-BRAVO) and (CoG-P1) 131
3.3.2 Set the equations equal to each other (ALPHA-BRAVO) and (CoG-P1) 133
3.3.3 Solve the x and y-coordinate (ALPHA-BRAVO) and (CoG-P1) 133
3.3.4 Use Pythagoras theorem to calculate the distance (D) from CoG to P1 134
3.3.5 Express both lines as an equation (CHARLY-DELTA) and (CoG-P2) 134
3.3.6 Set the equations equal to each other (CHARLY-DELTA) and (CoG-P2) 135
3.3.7 Solve the x and y-coordinate (CHARLY-DELTA) and (CoG-P2) 135
3.3.8 Use Pythagoras theorem to calculate the distance (D) from CoG to P2 135
3.3.9 Express both lines as an equation (DELTA-ALPHA) and (CoG-P3) 136
3.3.10 Set the equations equal to each other (DELTA-ALPHA) and (CoG-P3) 136
3.3.11 Solve the x and y-coordinate (DELTA-ALPHA) and (CoG-P3) 137
3.3.12 Use Pythagoras theorem to calculate the distance (D) from CoG to P3 137
3.3.13 Express both lines as an equation (BRAVO-CHARLY) and (CoG-P4) 137
3.3.14 Set the equations equal to each other (BRAVO-CHARLY) and (CoG-P4) 138
3.3.15 Solve the x and y-coordinate (BRAVO-CHARLY) and (CoG-P4) 138
3.3.16 Use Pythagoras theorem to calculate the distance (D) from CoG to P4 139
3.3.17 The aftermath 139
3.4 Center of Gravity kinetics, example 2 (mathematical) 141
3.4.1 Express both lines as an equation (CHARLY-DELTA) and (CoG-P1) 142
3.4.2 Set the equations equal to each other (CHARLY-DELTA) and (CoG-P1) 144
3.4.3 Solve the x and y-coordinate (CHARLY-DELTA) and (CoG-P1) 144
3.4.4 Use Pythagoras theorem to calculate the distance (D) from CoG to P1 144
3.4.5 Express both lines as an equation (BRAVO/BRAVO-CHARLY) and (CoG-P2) 145
3.4.6 Set the equations equal to each other (ALPHA/BRAVO-CHARLY) and (CoG-P2) 146
3.4.7 Solve the x and y-coordinate (ALPHA/BRAVO-CHARLY) and (CoG-P2) 146
3.4.8 Use Pythagoras theorem to calculate the distance (D) from CoG to P2 147
3.4.9 Express both lines as an equation (DELTA-ALPHA/BRAVO) and (CoG-P3) 147
3.4.10 Set the equations equal to each other (DELTA-ALPHA/BRAVO) and (CoG-P3) 149

3.4.11 Solve the x and y-coordinate (DELTA-ALPHA/BRAVO) and (CoG-P3) 149
3.4.12 Use Pythagoras theorem to calculate the distance (D) from CoG to P3.....150
3.4.13 The aftermath 150
3.5 Center of Gravity kinetics, example 3 (mathematical) 152
3.5.1 Express both lines as an equation (CHARLY-DELTA) and (CoG-P1).....153
3.5.2 Set the equations equal to each other (CHARLY-DELTA) and (CoG-P1) 155
3.5.3 Solve the x and y-coordinate (CHARLY-DELTA) and (CoG-P1).....155
3.5.4 Use Pythagoras theorem to calculate the distance (D) from CoG to P1 156
3.5.5 Express both lines as an equation (ALPHA/BRAVO-CHARLY) and (CoG-P2).....156
3.5.6 Set the equations equal to each other (ALPHA/BRAVO-CHARLY) and (CoG-P2)...158
3.5.7 Solve the x and y-coordinate (ALPHA/BRAVO-CHARLY) and (CoG-P2).....158
3.5.8 Use Pythagoras theorem to calculate the distance (D) from CoG to P2 158
3.5.9 Express both lines as an equation (DELTA-ALPHA/BRAVO) and (CoG-P3) 159
3.5.10 Set the equations equal to each other (DELTA-ALPHA/BRAVO) and (CoG-P3) ..160
3.5.11 Solve the x and y-coordinate (DELTA-ALPHA/BRAVO) and (CoG-P3) 161
3.5.12 Use Pythagoras theorem to calculate the distance (D) from CoG to P3.....161
3.5.13 The aftermath 162
3.6 Difference between a 3-point, a 4-point and a 1.5-wide system.....162
4 Hydraulic stability.....165
4.1 Hydraulic stability, 4-point suspension, example 1 165
4.1.1 Calculation of hydraulic stability angles, example 1 168
4.2 Hydraulic stability, 4-point suspension, example 2, influence of combined CoG 171
4.2.1 Calculation of hydraulic stability angles, example 2 171
4.3 Hydraulic stability, 4-point suspension, example 3, influence of the suspension 173
4.3.1 Calculation of hydraulic stability angles, example 3 173
4.4 Hydraulic stability, 3-point suspension, example 4 175
4.4.1 Calculation of hydraulic stability angles, example 4 177
4.5 Hydraulic stability, 1.5-wide configuration, example 5.....179
4.5.1 Calculation of hydraulic stability angles, example 5 181
4.6 Difference between a 3-point, a 4-point and a 1.5-wide system.....183
4.7 The aftermath.....185
5 Two different types of stability 187
5.1 Hydraulic stability statement 187
5.2 Structural stability statement 187
5.3 Two different types of stability arms 188
5.3.1 The relation between hydraulic $D_{Rcog\text{-}Px}$ and structural $D_{Rcog\text{-}Sx}$ stability arms.....188
5.4 The aftermath.....189
6 Structural stability.....191
6.1 Structural stability, 4-point suspension, example 1 191
6.1.1 Calculation of structural stability angles, example 1 195
6.1.1.1 Calculation of longitudinal structural stability angle towards S1 197
6.1.1.2 What are the loads in each suspensions group in this scenario.....199
6.1.1.3 Calculation of longitudinal structural stability angle towards S2 200
6.1.1.4 What are the loads in each suspensions group in this scenario.....202
6.1.1.5 Calculation of transverse structural stability angle towards S3 203
6.1.1.6 What are the loads in each suspensions group in this scenario.....205

6.1.1.7 Calculation of transverse structural stability angle towards S4 206
6.1.1.8 What are the loads in each suspensions group in this scenario 208
6.2 Structural stability, 4-point suspension, example 2, influence of the CoG 211
6.2.1 Calculation of structural stability angles, example 2 211
6.3 Structural stability, 4-point suspension, example 3, influence of the suspension 213
6.3.1 Calculation of structural stability angles, example 3 213
6.4 Structural stability, 3-point suspension, example 4 216
6.4.1 Calculation of structural stability angles, example 4 220
6.4.1.1 Calculation of longitudinal structural stability angle towards S1 222
6.4.1.2 What are the loads in each suspensions group in this scenario 224
6.4.1.3 Calculation of longitudinal structural stability angle towards S2 226
6.4.1.4 What are the loads in each suspensions group in this scenario 229
6.4.1.5 Calculation of longitudinal structural stability angle towards S3 230
6.4.1.6 What are the loads in each suspensions group in this scenario 233
6.5 Structural stability, 1.5-wide configuration, example 5 236
6.5.1 Calculation of structural stability angles, example 5 241
6.5.1.1 Calculation of longitudinal structural stability angle towards S1 241
6.5.1.2 What are the loads in each suspensions group in this scenario 245
6.5.1.3 Calculation of longitudinal structural stability angle towards S2 246
6.5.1.4 What are the loads in each suspensions group in this scenario 249
6.5.1.5 Calculation of longitudinal structural stability angle towards S3 251
6.5.1.6 What are the loads in each suspensions group in this scenario 254
6.6 Difference between a 3-point, a 4-point and a 1.5-wide system 256
6.7 The aftermath 256
7 Safe stability angles, limitations on Center of Gravity kinetics 259
7.1 How to interpret S_{HSA} 259
7.2 How to interpret S_{SSA} 259
7.3 Where do these angles originate from and why are they not equal in value 260
7.4 What if the safe angles are less than the safe stability limit 261
7.5 The aftermath 261
8 Limiting stability angle 263
8.1 Longitudinal limiting stability angle for 4-point suspension 264
8.2 Transverse limiting stability angle for 4-point suspension 267
8.3 Longitudinal limiting stability angle for 3-point suspension 270
8.4 Transverse limiting stability angle for 3-point suspension 273
8.5 The aftermath 278
9 Engineering case studies 281
9.1 Case study 1 281
9.1.1 Determine the CoS coordinates 282
9.1.2 Determine the P1, P2 and P3 coordinates 283
9.1.3 Determine $D_{Rcog\text{-}P1}$, $D_{Rcog\text{-}P2}$ and $D_{Rcog\text{-}P3}$ 285
9.1.4 Determine combined CoG 286
9.1.5 Determine hydraulic (H) stability 287
9.1.6 Determine the initial loads per suspension group 287
9.1.7 Determine the S1, S2 and S3 coordinates 289
9.1.8 Determine $D_{Rcog\text{-}S1}$, $D_{Rcog\text{-}S2}$ and $D_{Rcog\text{-}S3}$ 290

9.1.9 Determine structural (S) stability 290
9.1.10 In aftermath 291
9.2 Case study 2 293
9.2.1 Determine the CoS coordinates 294
9.2.2 Determine the P1, P2, P3 and P4 coordinates 295
9.2.3 Determine $D_{Rcog-P1}$, $D_{Rcog-P2}$, $D_{Rcog-P3}$, and $D_{Rcog-P4}$ 297
9.2.4 Determine combined CoG 298
9.2.5 Determine hydraulic (H) stability 299
9.2.6 Determine the initial loads per suspension group 299
9.2.7 Determine the S1, S2, S3 and S4 coordinates 301
9.2.8 Determine $D_{Rcog-S1}$, $D_{Rcog-S2}$, $D_{Rcog-S3}$ and $D_{Rcog-S4}$ 303
9.2.9 Determine structural (S) stability 303
9.2.10 In aftermath 303
10 About choosing the suspension groups 306
10.1 The guidelines 315
10.2 The aftermath 316
11 External forces 318
11.1 Acceleration forces 319
11.1.1 Acceleration forces, example 1 321
11.1.2 Acceleration forces, example 2 326
11.2 Curve or centrifugal forces 332
11.2.1 Curve forces, example 1 334
11.2.2 Curve forces, example 2 337
11.2.3 Curve forces in general 340
11.3 Wind forces 342
11.3.1 Wind forces, example 1 346
11.3.2 Wind forces, example 2 350
11.4 Influence of external forces on the hydraulic stability 355
11.5 Influence of external forces on the structural stability 355
11.5.1 Influence on a 4-point suspension configuration 356
11.5.1.1 Longitudinal structural stability towards S1 357
11.5.1.2 Longitudinal structural stability towards S3 358
11.5.2 Influence on a 3-point suspension configuration 360
11.5.2.1 Longitudinal structural stability towards S1 361
11.5.2.2 Longitudinal structural stability towards S3 363
11.6 The aftermath 366
12 Gradient forces 368
12.1 Gradient forces, example 1 370
12.2 Gradient forces, example 2 375
12.3 The aftermath 379
13 Lashing and securing 381
13.1 Reduction of the CoG height by using the combined CoG 381
13.1.1 Reduction of the CoG height by using the combined CoG, example 1 383
13.2 Securing against external forces 384
13.2.1 Securing against external forces, example 1 385
13.3 Securing against gradient forces 388

13.3.1 Securing against gradient forces, example 1 389
13.4 In summary; 389
13.5 Friction 390
13.5.1 The friction force 391
13.5.2 The friction factor μ (mu) 391
13.5.3 How to use friction to reduce lashing 392
13.5.4 Friction force, example 1 394
13.6 Applying lashing 396
13.6.1 Applying lashing, example 1 398
13.7 The aftermath 401
14 After thoughts 402
Table of Figures 403
Table of Pictures 408
Table of Equations 410
Abbreviations 411