

## บรรณานุกรม

- [1] ปิติศานต์ กร้ามาตร และสมนึก ตั้งเต็มสิริกุล, “การต้านทานซัลเฟตของตัวอย่างมอร์ตาร์ฝุ่นหินปูน,” การประชุมวิชาการคอนกรีตประจำปี, ครั้งที่ 3, 24-26 ตุลาคม 2550, ชลบุรี, 2550.
- [2] ชัย จาตุรพิทักษ์กุล และวีรชาติ ตั้งจิรภัทร, “ปูนซีเมนต์ ปอซโซลาน และคอนกรีต,” พิมพ์ครั้งที่ 2, ภาควิชาวิศวกรรมโยธา คณะวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี, 2552.
- [3] Vogelis et al., “Portland-limestone cement. Their properties and hydration compared to those of other composite cements,” *Cement & Concrete Composites (Electronic)*, 2005, Vol. 27, pp. 191-196. Available: Elsevier/Science Direct (3 may 2009).
- [4] จตุพร ชูตาภา และ วรพจน์ แสงราม, “แคลเซียมคาร์บอเนต (Calcium Carbonate:  $\text{CaCO}_3$ ),” *วิหารแดง*, ปีที่ 1, ฉบับที่ 6 มิถุนายน, 2552.
- [5] Kadri et al., “Combined effect of chemical nature and fineness of mineral powders on Portland cement hydration,” *RILEM (Electronic)*, 2009, pp. 5-6. Available: RILEM Union/RILEM (3 may 2009).
- [6] LIN Zongshou and ZHAO Qian, “Strength of Limestone-based Non-calcined Cement and its Properties,” *Journal of Wuhan University of Technology-Mater*, 2009.
- [7] Al-Amoudi, O.S.B., “Mechanisms of Sulfate in Plain and Blended Cement. a Review,” *Proceeding of the International Seminar, University of Dundee, Scotland, UK.*, 1999.
- [8] คณะอนุกรรมการคอนกรีตและวัสดุ ภายใต้คณะกรรมการวิชาการสาขาวิศวกรรมโยธา วิศวกรรมสถานแห่งประเทศไทยในพระบรมราชูปถัมภ์, “ความคงทนของคอนกรีต,” พิมพ์ครั้งที่ 1, สิงหาคม 2543.
- [9] Pitisan Krammart and Somnuk Tangtermsirikul “Expansion, Strength Reduction and Weight Loss of Fly Ash Concrete in Sulfate Solution,” *ASEAN Journal on Science & Technology for Delvelopment*, V 21, 2004, pp. 373-390.

- [10] Al-Amoudi O.S.B., Maslehuddin M., Saadi, M.M., 1995, "Effect of magnesium and sodium sulfate on the durability performance of plain and blended cements, ACI Materials Journal 92: pp.15-24.
- [11] Al-Dulaijan S.U., Maslehuddin M., Al-Zahrani M.M., Sharif A.M., Shameem M., Ibrahim M., 2003. "Sulfate resistance of plain and blended cements exposed to varying concentrations of sodium sulfate," Cement & Concrete Composites 25: Article in press.
- [12] สุขชัย สุขยานุศิษฐ์ และคณะ, "ผลกระทบของผงหินปูนต่อการขยายตัวของมอร์ต้าร์ในสารละลายโซเดียมซัลเฟต," การประชุมวิชาการคอนกรีตประจำปี, ครั้งที่ 5, 20-22 ตุลาคม 2552, นครราชสีมา, 2552.
- [13] Somnuk Tangtermsirikul, "Durability and Mix Design of Concrete," Printing House Thammasat University Rangsit Campus, 2003, pp. 86-87.

ภาคผนวก ก

แสดงตารางค่าการขยายตัวในสารละลายเซลล์เฟตของมอร์ตาร์วัสดุประสาน

ภาคผนวก ก

แสดงตารางค่าการขยายตัวในสารละลายซัลเฟตของตัวอย่างมอร์ตาร์

ตารางที่ ก.1 ค่าการขยายตัวในสารละลายซีเมนต์ของตัวอย่างมอร์ตาร์

| Mortars   | Sulfate Solution | Expansion of Paste Bars Specimens, % |        |        |        |        |         |         |         |         |         |         |         |         |         |         |         |          |
|-----------|------------------|--------------------------------------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
|           |                  | 0 week                               | 2 week | 3 week | 4 week | 8 week | 13 week | 20 week | 28 week | 36 week | 44 week | 52 week | 60 week | 68 week | 76 week | 84 week | 92 week | 100 week |
| C1        | NS               | 0                                    | 0.000  | -0.010 | 0.001  | 0.004  | 0.019   | 0.020   | 0.066   | 0.125   | 0.144   | 0.241   | 0.345   | 0.398   | 0.441   | 0.550   | 0.650   | -0.241   |
|           | MS               | 0                                    | 0.000  | 0.002  | 0.002  | 0.008  | 0.010   | 0.024   | 0.048   | 0.065   | 0.112   | 0.186   | 0.233   | 0.306   | 0.331   | 0.383   | 0.450   | -0.615   |
|           | NS+MS            | 0                                    | -0.002 | -      | 0.005  | 0.007  | 0.012   | 0.012   | 0.054   | 0.107   | 0.123   | 0.204   | 0.245   | 0.310   | 0.356   | 0.410   | 0.458   | -0.078   |
| C1-5LP4   | NS               | 0                                    | -0.010 | -0.008 | -0.001 | 0.001  | 0.003   | 0.017   | 0.019   | 0.101   | 0.124   | 0.189   | 0.299   | 0.335   | 0.388   | 0.439   | 0.512   | -0.613   |
|           | MS               | 0                                    | -0.001 | 0.001  | 0.001  | 0.003  | 0.005   | 0.009   | 0.033   | 0.155   | 0.172   | 0.236   | 0.398   | 0.448   | 0.484   | 0.496   | 0.601   | -0.466   |
|           | NS+MS            | 0                                    | -0.003 | -0.002 | 0.001  | 0.001  | 0.004   | 0.005   | 0.018   | 0.100   | 0.117   | 0.202   | 0.275   | 0.333   | 0.349   | 0.388   | 0.396   | -1.079   |
| C1-5LP14  | NS               | 0                                    | 0.005  | 0.004  | 0.005  | 0.006  | 0.012   | 0.033   | 0.067   | 0.125   | 0.213   | 0.316   | 0.419   | 0.480   | 0.488   | 0.599   | 0.635   | -0.589   |
|           | MS               | 0                                    | -0.001 | 0.004  | 0.006  | 0.009  | 0.012   | 0.035   | 0.048   | 0.096   | 0.172   | 0.278   | 0.334   | 0.361   | 0.410   | 0.437   | 0.492   | -0.419   |
|           | NS+MS            | 0                                    | 0.002  | 0.004  | 0.007  | 0.007  | 0.009   | 0.018   | 0.051   | 0.057   | 0.115   | 0.296   | 0.322   | 0.392   | 0.426   | 0.475   | 0.509   | -0.536   |
| C1-10LP4  | NS               | 0                                    | -0.003 | 0.002  | 0.003  | 0.008  | 0.014   | 0.029   | 0.045   | 0.167   | 0.209   | 0.330   | 0.460   | 0.498   | 0.511   | 0.580   | 0.647   | -0.683   |
|           | MS               | 0                                    | -0.002 | 0.002  | 0.004  | 0.008  | 0.009   | 0.015   | 0.011   | 0.123   | 0.141   | 0.188   | 0.338   | 0.425   | 0.496   | 0.525   | 0.592   | -0.826   |
|           | NS+MS            | 0                                    | -0.003 | -0.001 | 0.000  | 0.003  | 0.012   | 0.014   | 0.019   | 0.086   | 0.107   | 0.233   | 0.359   | 0.379   | 0.423   | 0.523   | 0.539   | -0.876   |
| C1-10LP14 | NS               | 0                                    | 0.000  | 0.001  | 0.020  | 0.028  | 0.030   | 0.063   | 0.114   | 0.251   | 0.338   | 0.469   | 0.510   | 0.705   | 0.738   | 0.815   | 0.995   | -0.856   |
|           | MS               | 0                                    | 0.000  | 0.006  | 0.007  | 0.029  | 0.030   | 0.044   | 0.076   | 0.081   | 0.144   | 0.301   | 0.454   | 0.510   | 0.558   | 0.597   | 0.646   | -0.607   |
|           | NS+MS            | 0                                    | 0.004  | -0.001 | 0.005  | 0.010  | 0.006   | 0.010   | 0.042   | 0.084   | 0.164   | 0.334   | 0.460   | 0.556   | 0.576   | 0.636   | 0.643   | -0.191   |
| C1-20FA   | NS               | 0                                    | 0.000  | 0.004  | -0.006 | 0.003  | 0.005   | 0.012   | 0.022   | 0.028   | 0.054   | 0.074   | 0.091   | 0.115   | 0.120   | 0.136   | 0.222   | -0.927   |
|           | MS               | 0                                    | 0.000  | 0.008  | -0.006 | 0.005  | 0.001   | 0.010   | 0.002   | -0.004  | 0.019   | 0.032   | 0.050   | 0.077   | 0.104   | 0.121   | 0.127   | -0.674   |
|           | NS+MS            | 0                                    | 0.000  | 0.004  | -0.011 | 0.000  | -0.003  | -0.002  | 0.007   | 0.000   | 0.010   | 0.031   | 0.038   | 0.080   | 0.109   | 0.127   | 0.134   | -0.566   |
| C1-40FA   | NS               | 0                                    | 0.003  | -0.006 | -0.002 | 0.005  | 0.007   | 0.002   | 0.006   | 0.009   | 0.006   | 0.007   | 0.006   | 0.013   | 0.050   | 0.083   | 0.106   | -0.440   |
|           | MS               | 0                                    | -0.002 | -0.009 | 0.006  | 0.009  | 0.004   | 0.008   | 0.007   | 0.008   | 0.010   | 0.012   | 0.014   | 0.019   | 0.021   | 0.023   | 0.027   | -0.753   |
|           | NS+MS            | 0                                    | -0.002 | -0.004 | -0.002 | -0.003 | -0.002  | -0.001  | 0.000   | 0.002   | 0.004   | 0.005   | 0.007   | 0.013   | 0.029   | 0.079   | 0.093   | -0.215   |

ตารางที่ ก.1 (ต่อ)

| Mortars         | Sulfate Solution | Expansion of Paste Bars Specimens, % |           |           |           |           |            |            |            |            |            |            |            |            |            |            |            |             |
|-----------------|------------------|--------------------------------------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
|                 |                  | 0<br>week                            | 2<br>week | 3<br>week | 4<br>week | 8<br>week | 13<br>week | 20<br>week | 28<br>week | 36<br>week | 44<br>week | 52<br>week | 60<br>week | 68<br>week | 76<br>week | 84<br>week | 92<br>week | 100<br>week |
| C1-15FA -5LP4   | NS               | 0                                    | -0.004    | -0.001    | 0.005     | 0.007     | 0.033      | 0.114      | 0.198      | 0.348      | 0.430      | 0.581      | 0.782      | 0.906      | 0.977      | 1.075      | 1.085      | -0.493      |
|                 | MS               | 0                                    | 0.000     | 0.001     | 0.000     | -0.004    | 0.001      | 0.000      | 0.048      | 0.120      | 0.227      | 0.334      | 0.455      | 0.523      | 0.643      | 0.663      | 0.708      | -0.546      |
|                 | NS+MS            | 0                                    | 0.000     | 0.004     | 0.004     | 0.009     | 0.010      | 0.008      | 0.024      | 0.031      | 0.060      | 0.146      | 0.256      | 0.329      | 0.406      | 0.468      | 0.532      | -0.382      |
| C1-10FA -10LP4  | NS               | 0                                    | -0.009    | 0.000     | 0.001     | -0.001    | 0.018      | 0.040      | 0.119      | 0.206      | 0.294      | 0.360      | 0.588      | 0.682      | 0.710      | 0.775      | 0.875      | 0.041       |
|                 | MS               | 0                                    | -0.006    | -0.007    | -0.003    | -0.001    | -0.002     | 0.005      | 0.041      | 0.147      | 0.295      | 0.491      | 0.616      | 0.641      | 0.750      | 0.806      | 0.847      | -1.261      |
|                 | NS+MS            | 0                                    | -0.001    | -0.005    | -0.003    | -0.003    | 0.006      | 0.012      | 0.022      | 0.042      | 0.062      | 0.197      | 0.378      | 0.444      | 0.503      | 0.553      | 0.584      | -0.551      |
| C1-30FA -10LP4  | NS               | 0                                    | -0.006    | -0.013    | 0.002     | -0.012    | 0.002      | -0.001     | 0.005      | -0.002     | 0.010      | 0.044      | 0.045      | 0.060      | 0.071      | 0.080      | 0.105      | -0.954      |
|                 | MS               | 0                                    | 0.010     | -0.019    | 0.013     | -0.009    | 0.008      | 0.004      | 0.000      | -0.002     | 0.008      | 0.020      | 0.027      | 0.033      | 0.050      | 0.049      | 0.072      | -1.175      |
|                 | NS+MS            | 0                                    | 0.011     | -0.017    | 0.016     | -0.027    | 0.010      | -0.002     | 0.004      | -0.003     | 0.002      | 0.030      | 0.040      | 0.038      | 0.051      | 0.078      | 0.093      | -0.161      |
| C1-25FA -15LP4  | NS               | 0                                    | -0.004    | -0.007    | 0.008     | 0.011     | 0.014      | 0.023      | 0.032      | 0.039      | 0.051      | 0.102      | 0.127      | 0.146      | 0.165      | 0.200      | 0.283      | -1.596      |
|                 | MS               | 0                                    | -0.001    | -0.004    | 0.001     | 0.004     | 0.002      | 0.004      | 0.006      | 0.004      | 0.035      | 0.073      | 0.098      | 0.133      | 0.141      | 0.186      | 0.194      | 0.136       |
|                 | NS+MS            | 0                                    | -0.004    | -0.004    | 0.000     | 0.004     | 0.003      | 0.003      | 0.006      | 0.007      | 0.014      | 0.028      | 0.046      | 0.057      | 0.061      | 0.096      | 0.122      | 0.129       |
| C1-15FA -5LP14  | NS               | 0                                    | -0.001    | -0.001    | 0.003     | -0.002    | -0.004     | 0.011      | 0.025      | 0.058      | 0.086      | 0.149      | 0.194      | 0.222      | 0.252      | 0.286      | 0.333      | -0.805      |
|                 | MS               | 0                                    | 0.002     | -0.001    | -0.001    | 0.000     | -0.004     | 0.007      | 0.010      | 0.009      | 0.039      | 0.079      | 0.106      | 0.113      | 0.134      | 0.144      | 0.151      | -0.914      |
|                 | NS+MS            | 0                                    | 0.006     | 0.005     | 0.000     | -0.001    | 0.002      | 0.010      | 0.014      | 0.017      | 0.018      | 0.022      | 0.040      | 0.046      | 0.081      | 0.100      | 0.119      | -0.837      |
| C1-10FA -10LP14 | NS               | 0                                    | 0.001     | -0.006    | 0.004     | 0.004     | 0.018      | 0.057      | 0.113      | 0.159      | 0.275      | 0.388      | 0.438      | 0.457      | 0.570      | 0.668      | 0.740      | -0.395      |
|                 | MS               | 0                                    | -0.006    | -0.005    | 0.006     | 0.009     | 0.007      | 0.000      | 0.010      | 0.014      | 0.048      | 0.072      | 0.133      | 0.204      | 0.248      | 0.318      | 0.344      | 0.089       |
|                 | NS+MS            | 0                                    | 0.000     | 0.000     | 0.002     | 0.000     | -0.004     | 0.007      | 0.005      | 0.011      | 0.014      | 0.039      | 0.051      | 0.083      | 0.094      | 0.109      | 0.116      | -0.853      |
| C1-30FA -10LP14 | NS               | 0                                    | -0.001    | 0.003     | 0.001     | 0.002     | 0.006      | 0.002      | 0.006      | 0.004      | 0.011      | 0.011      | 0.013      | 0.020      | 0.025      | 0.034      | 0.072      | -1.406      |
|                 | MS               | 0                                    | 0.001     | 0.005     | 0.005     | 0.005     | 0.005      | -0.005     | -0.006     | -0.002     | 0.009      | 0.007      | 0.009      | 0.012      | 0.013      | 0.009      | 0.012      | -0.698      |
|                 | NS+MS            | 0                                    | 0.000     | 0.002     | -0.005    | 0.001     | 0.009      | -0.011     | -0.003     | -0.004     | 0.004      | 0.000      | -0.002     | 0.005      | 0.004      | 0.005      | 0.011      | -0.505      |

ตารางที่ ก.1 (ต่อ)

| Mortars         | Sulfate Solution | Expansion of Paste Bars Specimens, % |        |        |        |       |        |        |       |       |       |       |       |       |       |       |       |        |
|-----------------|------------------|--------------------------------------|--------|--------|--------|-------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
|                 |                  | 0                                    | 2      | 3      | 4      | 8     | 13     | 20     | 28    | 36    | 44    | 52    | 60    | 68    | 76    | 84    | 92    | 100    |
| C1-25FA -15LP14 | NS               | 0                                    | -0.002 | -0.001 | -0.004 | 0.002 | 0.014  | 0.016  | 0.022 | 0.055 | 0.078 | 0.095 | 0.103 | 0.111 | 0.121 | 0.124 | 0.167 | -0.638 |
|                 | MS               | 0                                    | 0.001  | -0.002 | -0.001 | 0.005 | 0.003  | 0.007  | 0.006 | 0.013 | 0.014 | 0.059 | 0.087 | 0.104 | 0.201 | 0.218 | 0.279 | -0.997 |
|                 | NS+MS            | 0                                    | 0.004  | 0.001  | 0.004  | 0.008 | 0.007  | 0.008  | 0.012 | 0.013 | 0.016 | 0.014 | 0.020 | 0.027 | 0.045 | 0.046 | 0.058 | -0.410 |
| C5              | NS               | 0                                    | 0.004  | 0.005  | 0.004  | 0.005 | 0.009  | 0.020  | 0.037 | 0.097 | 0.109 | 0.224 | 0.322 | 0.336 | 0.403 | 0.437 | 0.505 | -0.881 |
|                 | MS               | 0                                    | -0.005 | -0.006 | 0.006  | 0.006 | 0.006  | 0.013  | 0.030 | 0.037 | 0.100 | 0.230 | 0.280 | 0.300 | 0.310 | 0.360 | 0.390 | -1.021 |
|                 | NS+MS            | 0                                    | 0.001  | 0.006  | 0.006  | 0.014 | 0.018  | 0.022  | 0.035 | 0.085 | 0.095 | 0.191 | 0.300 | 0.320 | 0.350 | 0.365 | 0.371 | -0.865 |
| C5-5LP4         | NS               | 0                                    | 0.003  | 0.004  | 0.005  | 0.005 | 0.009  | 0.011  | 0.028 | 0.057 | 0.077 | 0.110 | 0.131 | 0.178 | 0.209 | 0.262 | 0.337 | -0.761 |
|                 | MS               | 0                                    | 0.001  | 0.003  | 0.004  | 0.006 | 0.008  | 0.010  | 0.014 | 0.122 | 0.165 | 0.281 | 0.557 | 0.647 | 0.703 | 0.744 | 0.782 | -0.613 |
|                 | NS+MS            | 0                                    | 0.001  | 0.005  | 0.002  | 0.006 | 0.008  | 0.008  | 0.013 | 0.061 | 0.071 | 0.111 | 0.293 | 0.380 | 0.424 | 0.444 | 0.491 | -1.064 |
| C5-5LP14        | NS               | 0                                    | 0.002  | 0.006  | -0.001 | 0.006 | -0.001 | 0.005  | 0.016 | 0.020 | 0.032 | 0.058 | 0.074 | 0.093 | 0.107 | 0.119 | 0.198 | -0.550 |
|                 | MS               | 0                                    | 0.010  | 0.010  | 0.008  | 0.008 | 0.000  | 0.017  | 0.028 | 0.048 | 0.121 | 0.227 | 0.286 | 0.338 | 0.421 | 0.447 | 0.467 | -0.958 |
|                 | NS+MS            | 0                                    | 0.007  | 0.009  | 0.006  | 0.003 | 0.001  | -0.001 | 0.015 | 0.019 | 0.034 | 0.106 | 0.174 | 0.230 | 0.264 | 0.303 | 0.322 | -0.293 |
| C5-10LP4        | NS               | 0                                    | -0.004 | 0.001  | 0.005  | 0.003 | 0.006  | 0.011  | 0.016 | 0.036 | 0.061 | 0.107 | 0.152 | 0.170 | 0.222 | 0.267 | 0.376 | -0.561 |
|                 | MS               | 0                                    | -0.001 | 0.001  | 0.004  | 0.005 | 0.002  | 0.006  | 0.012 | 0.019 | 0.101 | 0.214 | 0.442 | 0.529 | 0.647 | 0.668 | 0.725 | -0.500 |
|                 | NS+MS            | 0                                    | -0.009 | 0.014  | 0.020  | 0.009 | 0.011  | 0.008  | 0.028 | 0.084 | 0.097 | 0.161 | 0.330 | 0.418 | 0.438 | 0.486 | 0.562 | -0.656 |
| C5-10LP14       | NS               | 0                                    | 0.005  | 0.014  | 0.007  | 0.011 | 0.008  | 0.014  | 0.019 | 0.024 | 0.044 | 0.060 | 0.074 | 0.100 | 0.129 | 0.161 | 0.200 | -0.836 |
|                 | MS               | 0                                    | 0.010  | 0.022  | 0.016  | 0.020 | 0.018  | 0.012  | 0.034 | 0.035 | 0.078 | 0.091 | 0.107 | 0.258 | 0.325 | 0.345 | 0.366 | -0.849 |
|                 | NS+MS            | 0                                    | 0.000  | 0.011  | 0.010  | 0.010 | 0.009  | 0.008  | 0.016 | 0.020 | 0.023 | 0.061 | 0.068 | 0.114 | 0.199 | 0.200 | 0.264 | -0.056 |
| C5-20FA         | NS               | 0                                    | 0.000  | 0.002  | 0.009  | 0.006 | 0.008  | 0.015  | 0.025 | 0.035 | 0.044 | 0.076 | 0.107 | 0.112 | 0.120 | 0.180 | 0.296 | -0.467 |
|                 | MS               | 0                                    | 0.000  | 0.007  | 0.008  | 0.004 | 0.005  | 0.005  | 0.008 | 0.022 | 0.043 | 0.054 | 0.059 | 0.073 | 0.165 | 0.186 | 0.271 | -0.354 |
|                 | NS+MS            | 0                                    | 0.000  | 0.010  | 0.007  | 0.006 | 0.008  | 0.007  | 0.012 | 0.013 | 0.021 | 0.023 | 0.036 | 0.045 | 0.060 | 0.077 | 0.104 | -0.768 |

ตารางที่ ก.1 (ต่อ)

| Mortars         | Sulfate Solution | Expansion of Paste Bars Specimens, % |        |        |        |        |         |         |         |         |         |         |         |         |         |         |         |          |
|-----------------|------------------|--------------------------------------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
|                 |                  | 0 week                               | 2 week | 3 week | 4 week | 8 week | 13 week | 20 week | 28 week | 36 week | 44 week | 52 week | 60 week | 68 week | 76 week | 84 week | 92 week | 100 week |
| C1+25FA -15LP14 | NS               | 0                                    | -0.002 | -0.001 | -0.004 | 0.002  | 0.014   | 0.016   | 0.022   | 0.055   | 0.078   | 0.095   | 0.103   | 0.111   | 0.121   | 0.124   | 0.167   | -0.638   |
|                 | MS               | 0                                    | 0.001  | -0.002 | -0.001 | 0.005  | 0.003   | 0.007   | 0.006   | 0.013   | 0.014   | 0.059   | 0.087   | 0.104   | 0.201   | 0.218   | 0.279   | -0.997   |
|                 | NS+MS            | 0                                    | 0.004  | 0.001  | 0.004  | 0.008  | 0.007   | 0.008   | 0.012   | 0.013   | 0.016   | 0.014   | 0.020   | 0.027   | 0.045   | 0.046   | 0.058   | -0.410   |
| C5              | NS               | 0                                    | 0.004  | 0.005  | 0.004  | 0.005  | 0.009   | 0.020   | 0.037   | 0.097   | 0.109   | 0.224   | 0.322   | 0.336   | 0.403   | 0.437   | 0.505   | -0.881   |
|                 | MS               | 0                                    | -0.005 | -0.006 | 0.006  | 0.006  | 0.006   | 0.013   | 0.030   | 0.037   | 0.100   | 0.230   | 0.280   | 0.300   | 0.310   | 0.360   | 0.390   | -1.021   |
|                 | NS+MS            | 0                                    | 0.001  | 0.006  | 0.006  | 0.014  | 0.018   | 0.022   | 0.035   | 0.085   | 0.095   | 0.191   | 0.300   | 0.320   | 0.350   | 0.365   | 0.371   | -0.865   |
| C5-5LP4         | NS               | 0                                    | 0.003  | 0.004  | 0.005  | 0.005  | 0.009   | 0.011   | 0.028   | 0.057   | 0.077   | 0.110   | 0.131   | 0.178   | 0.209   | 0.262   | 0.337   | -0.761   |
|                 | MS               | 0                                    | 0.001  | 0.003  | 0.004  | 0.006  | 0.008   | 0.010   | 0.014   | 0.122   | 0.165   | 0.281   | 0.557   | 0.647   | 0.703   | 0.744   | 0.782   | -0.613   |
|                 | NS+MS            | 0                                    | 0.001  | 0.005  | 0.002  | 0.006  | 0.008   | 0.009   | 0.013   | 0.061   | 0.071   | 0.111   | 0.293   | 0.380   | 0.424   | 0.444   | 0.491   | -1.064   |
| C5-5LP14        | NS               | 0                                    | 0.002  | 0.006  | -0.001 | 0.006  | -0.001  | 0.005   | 0.016   | 0.020   | 0.032   | 0.058   | 0.074   | 0.093   | 0.107   | 0.119   | 0.198   | -0.550   |
|                 | MS               | 0                                    | 0.010  | 0.010  | 0.008  | 0.008  | 0.000   | 0.017   | 0.028   | 0.048   | 0.121   | 0.227   | 0.286   | 0.338   | 0.421   | 0.447   | 0.467   | -0.958   |
|                 | NS+MS            | 0                                    | 0.007  | 0.009  | 0.006  | 0.003  | 0.001   | -0.001  | 0.015   | 0.019   | 0.034   | 0.106   | 0.174   | 0.230   | 0.264   | 0.303   | 0.322   | -0.293   |
| C5-10LP4        | NS               | 0                                    | -0.004 | 0.001  | 0.005  | 0.003  | 0.006   | 0.011   | 0.016   | 0.036   | 0.061   | 0.107   | 0.152   | 0.170   | 0.222   | 0.267   | 0.376   | -0.561   |
|                 | MS               | 0                                    | -0.001 | 0.001  | 0.004  | 0.005  | 0.002   | 0.006   | 0.012   | 0.019   | 0.101   | 0.214   | 0.442   | 0.529   | 0.647   | 0.668   | 0.725   | -0.500   |
|                 | NS+MS            | 0                                    | -0.009 | 0.014  | 0.020  | 0.009  | 0.011   | 0.008   | 0.028   | 0.084   | 0.097   | 0.161   | 0.330   | 0.418   | 0.438   | 0.486   | 0.562   | -0.656   |
| C5-10LP14       | NS               | 0                                    | 0.005  | 0.014  | 0.007  | 0.011  | 0.008   | 0.014   | 0.019   | 0.024   | 0.044   | 0.060   | 0.074   | 0.100   | 0.129   | 0.161   | 0.200   | -0.836   |
|                 | MS               | 0                                    | 0.010  | 0.022  | 0.016  | 0.020  | 0.018   | 0.012   | 0.034   | 0.035   | 0.078   | 0.091   | 0.107   | 0.258   | 0.325   | 0.345   | 0.366   | -0.849   |
|                 | NS+MS            | 0                                    | 0.000  | 0.011  | 0.010  | 0.010  | 0.009   | 0.008   | 0.016   | 0.020   | 0.023   | 0.061   | 0.068   | 0.114   | 0.199   | 0.200   | 0.264   | -0.056   |
| C5-20FA         | NS               | 0                                    | 0.000  | 0.002  | 0.009  | 0.006  | 0.008   | 0.015   | 0.025   | 0.035   | 0.044   | 0.076   | 0.107   | 0.112   | 0.120   | 0.180   | 0.296   | -0.467   |
|                 | MS               | 0                                    | 0.000  | 0.007  | 0.008  | 0.004  | 0.005   | 0.005   | 0.008   | 0.022   | 0.043   | 0.054   | 0.059   | 0.073   | 0.165   | 0.186   | 0.271   | -0.354   |
|                 | NS+MS            | 0                                    | 0.000  | 0.010  | 0.007  | 0.006  | 0.008   | 0.007   | 0.012   | 0.013   | 0.021   | 0.023   | 0.036   | 0.045   | 0.060   | 0.077   | 0.104   | -0.768   |

ตารางที่ ก.1 (ต่อ)

| Mortars         | Sulfate Solution | Expansion of Paste Bars Specimens, % |           |           |           |           |            |            |            |            |            |            |            |            |            |            |            |             |
|-----------------|------------------|--------------------------------------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
|                 |                  | 0<br>week                            | 2<br>week | 3<br>week | 4<br>week | 8<br>week | 13<br>week | 20<br>week | 28<br>week | 36<br>week | 44<br>week | 52<br>week | 60<br>week | 68<br>week | 76<br>week | 84<br>week | 92<br>week | 100<br>week |
| C5-30FA -10LP14 | NS               | 0                                    | -0.001    | 0.004     | 0.000     | 0.005     | 0.003      | 0.012      | 0.010      | 0.011      | 0.021      | 0.019      | 0.021      | 0.019      | 0.039      | 0.036      | 0.049      | -1.479      |
|                 | MS               | 0                                    | -0.004    | -0.003    | 0.002     | 0.006     | 0.002      | 0.000      | 0.001      | 0.008      | 0.016      | 0.016      | 0.018      | 0.019      | 0.014      | 0.025      | 0.050      | -1.149      |
|                 | NS+MS            | 0                                    | -0.001    | 0.001     | -0.002    | 0.002     | -0.001     | 0.001      | 0.001      | 0.006      | 0.011      | 0.014      | 0.019      | 0.022      | 0.019      | 0.027      | 0.021      | -1.092      |
| C5-25FA -15LP14 | NS               | 0                                    | -0.008    | -0.011    | -0.004    | -0.004    | 0.000      | 0.014      | 0.015      | 0.020      | 0.021      | 0.023      | 0.020      | 0.032      | 0.033      | 0.043      | 0.064      | -1.385      |
|                 | MS               | 0                                    | -0.001    | -0.002    | -0.009    | 0.000     | 0.002      | 0.005      | -0.003     | -0.002     | 0.004      | 0.007      | 0.011      | 0.028      | 0.041      | 0.062      | 0.076      | -0.971      |
|                 | NS+MS            | 0                                    | -0.001    | -0.002    | 0.002     | 0.002     | 0.001      | 0.004      | 0.006      | 0.018      | 0.019      | 0.018      | 0.027      | 0.036      | 0.040      | 0.047      | 0.048      | 0.030       |

ภาคผนวก ข

ตารางแสดงค่าการสูญเสียน้ำหนักในสารละลายซัลเฟตของตัวอย่างมอร์ต้าร์



ตารางที่ ข.1 ค่าการสูญเสียน้ำหนักในสารละลายซัลเฟตของตัวอย่างมอร์ตาร์ที่อายุ 92 สัปดาห์ (644 วัน)

| Mortars         | Weight loss at 92 weeks in sulfate solution, % |      |         |
|-----------------|------------------------------------------------|------|---------|
|                 | NS                                             | MS   | NS + MS |
| C1              | 0.77                                           | 3.23 | 2.74    |
| C1-5LP4         | 0.50                                           | 2.53 | 2.72    |
| C1-5LP14        | 0.29                                           | 3.29 | 1.51    |
| C1-10LP4        | -0.17                                          | 2.36 | 2.00    |
| C1-10LP14       | 0.15                                           | 3.31 | 2.72    |
| C1-20FA         | -0.28                                          | 4.97 | 2.60    |
| C1-40FA         | -0.05                                          | 6.09 | 3.12    |
| C1-15FA -5LP4   | -0.35                                          | 3.55 | 1.86    |
| C1-10FA -10LP4  | -0.63                                          | 2.65 | 0.82    |
| C1-30FA -10LP4  | -0.67                                          | 1.90 | 0.72    |
| C1-25FA -15LP4  | -0.70                                          | 1.68 | 0.41    |
| C1-15FA -5LP14  | -0.25                                          | 2.85 | 0.47    |
| C1-10FA -10LP14 | -1.12                                          | 2.57 | 1.92    |
| C1-30FA -10LP14 | -0.50                                          | 2.71 | 1.32    |
| C1-25FA -15LP14 | -0.61                                          | 3.22 | 1.42    |
| C5              | 0.40                                           | 2.95 | 2.52    |
| C5-5LP4         | 0.02                                           | 2.86 | 2.93    |
| C5-5LP14        | 0.41                                           | 2.73 | 1.39    |
| C5-10LP4        | -0.44                                          | 3.40 | 2.27    |
| C5-10LP14       | 0.53                                           | 3.24 | 2.48    |
| C5-20FA         | -0.73                                          | 3.55 | 2.22    |
| C5-40FA         | -0.59                                          | 5.63 | 2.26    |
| C5-15FA -5LP4   | -0.24                                          | 2.86 | 2.28    |
| C5-10FA -10LP4  | -0.36                                          | 2.85 | 1.81    |
| C5-30FA -10LP4  | -0.06                                          | 4.58 | 1.23    |
| C5-25FA -15LP4  | -0.36                                          | 3.79 | 1.43    |
| C5-15FA -5LP14  | -0.60                                          | 4.47 | 2.55    |
| C5-10FA -10LP14 | -0.71                                          | 3.38 | 2.39    |
| C5-30FA -10LP14 | -0.11                                          | 3.19 | 2.48    |
| C5-25FA -15LP14 | -0.61                                          | 2.20 | 1.80    |

