Relaxation Loss – AERB/SS/CSE-1

$$p(t) = k_1 \, k_2 \, \rho_{1000} \, k_t$$

K_1= Factor based on fraction of Initial Prestress

k_2 = T/20, T=avg. temp. of structure (^{o}C)

$k_t = (t/1000)^{\alpha}$,

α = 0.12 (normal relaxation steel),

= 0.19 (low relaxation steel)

Relaxation Loss – CEB FIP

As per Clause 2.3.4.5 and Fig. 2.3.3:

$(\rho_{1000})_{\text{corr. to } \sigma po/fptk} = 2\ \%$

(for class 2 improved relaxation characteristics for wires and strands)

Relaxation up to 30 years, $\rho_t = \rho_{1000}(t/1000)^k$, t is in hours

where $k \approx \log(\rho_{1000}/\rho_{100})$

= 0.12 for relaxation class 1

= 0.19 for relaxation class 2

Relaxation Loss – Euro Code E2

<u>As per Clause 4.2.3.4 and Fig. 4.8:</u>

$(\rho_{1000})_{\text{corr. to } \sigma po/fptk}$ = 2.5% (for class 2, strands)

<u>As per Cl. No. 4.2.3.4 (2)</u>

The long term values of the relaxation losses may be assumed to be|**<u>three times</u>**|the relaxation losses after 1000 h.

Relaxation Loss – IS: 1343 - 1980

TABLE 4: RELAXATION LOSSES FOR PRESTRESSING STEEL AT 1000 H AT 27^{o}C

Initial Stress	Relaxation Loss
(1)	(2)
	N / mm^2
$0.5f_p$	0
$0.6f_p$	35
$0.7f_p$	70
$0.8f_p$	90

Note - f_p is the characteristic strength of prestressing steel

Relaxation Loss – IRC – 18 : 2000

TABLE 4A: (IRC:18-2000) Relaxation loss at 1000 hours at $20^oC \pm 2^oC$ (as % of initial stress)

Initial stress	Relaxation Loss for Normal relaxation steel (%)	Relaxation Loss for low relaxation steel (%)
0.5 fp	0	0
0.6 fp	2.5	1.25
0.7 fp	5.0	2.5
0.8 fp	9.0	4.5

Note: (i) For intermediate values linear interpolation may be done.

(ii) fp = U.T.S. of steel.

Relaxation Loss – BPEL-91

The final loss of tension due to the relaxation of the steel is given by:

$$\Delta\sigma_{\rho} = \frac{6}{100}\rho_{1000}\left(\frac{\sigma_{pi}(x)}{f_{prg}} - \mu_0\right)\sigma_{pi}(x)$$

μ_0 being a coefficient equal to:

0.43 - for tendons with a very small relaxation (VSR)
0.3 - for tendons with normal relaxation (NR)
0.35 - for other tendons

Relaxation Loss – Canadian

In lieu of detailed information from the steel manufacturer the intrinsic relaxation of prestressing tendons may be predicted as:

$$f_{re}(t) = \frac{\log t}{k_1}\left(\frac{f_{psi}}{f_{py}} - 0.55\right) f_{psi}$$

f_{re} (t) = intrinsic relaxation at time *t* (under constant strain)

f_{psi} = initial stress in tendon after stressing

f_{py} = 0.85 f_{pu} for stress relieved wires and strands

0.90 f_{pu} for low realxation strands

f_{pu} = tensile strength of tendon

t = time since prestressing (hours)

k_1 = 10 to 12 for stress relieved steel, 45 for low relaxation steel

Relaxation Loss – ACI 209R

Table 4.4.1.3 Values of $(f_{sr})_t$ and $(f_{sr})_u$ for Wires and Strands

Wire or Strand		$(f_{sr})_t$ for f_{si}/f_{py} from 0.65 to 0.80	$(f_{sr})_u$ at $t = 10^5$ hours
Steel	Stress Relieved	$0.015\ f_{si}\ (\log_{10} t)$	$0.075\ f_{si}$
	Stabilized (Low Relaxation)	$0.005\ f_{si}\ (\log_{10} t)$	$0.025\ f_{si}$