

KAWASAKI STEEL TECHNICAL REPORT

No.32 (March 1995)

Ironmaking Technology, Secondary Refining,
and Center-Segregation Control with Forging in CC

Concept of Continuous Forging Process and Experimental Analysis of Forged Blooms

Shinji Kojima, Hisakazu Mizota, Koichi Kushida

Synopsis :

With a view to substantially improving centerline segregation, the authors developed the continuous forging process, based on a completely new solidification mechanism. In the new method, the unsolidified bloom is subjected to heavy reduction at the stage of final solidification by anvils installed in the strand line. The effectiveness of the method has been confirmed using commercial continuous bloom casters, where it was found that centerline segregation can be eliminated and the segregation ratio of carbon C/C_0 can be controlled to an aimed value between 0.6 and 1.0 by choosing an appropriate ratio of reduction to the unsolidified thickness. It was also found that semi-macro segregation can be reduced and internal quality is quite stable in spite of deviations in casting conditions during actual operation.

(c)JFE Steel Corporation, 2003

The body can be viewed from the next page.

Concept of Continuous Forging Process and Experimental Analysis of Formed Blows*

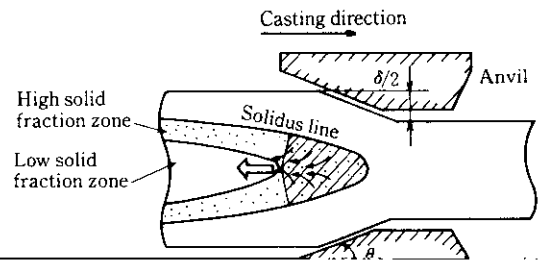
Synopsis:

...

2 Concept of Continuous Forging Process

2.1 Mechanism of Centerline Segregation in Continuous Casting

Steel includes C, Si, Mn, P, S, and other non-ferrous metal and nonmetallic components and demonstrates a



together with the results for δ_1 . This δ_2 shows the

occurs when the amount of center-area reduction is

all the solid phase in the apparent unsolidified begins when the amount of reduction exceeds the

internal cracking, even under high reduction, by forming a compressive stress field. In addition, there are few

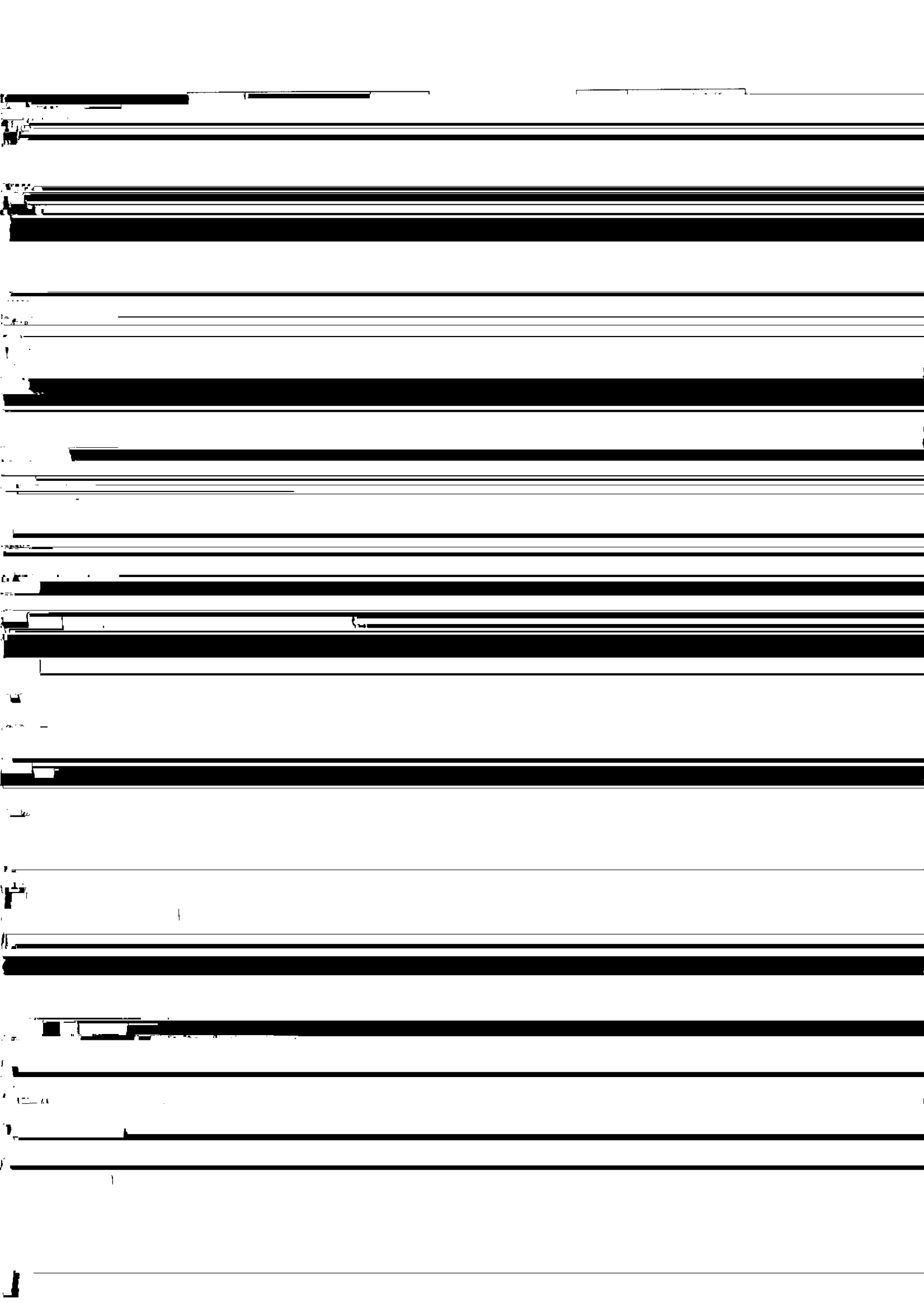
is possible without either internal or surface cracks, provided appropriate forming conditions are used.

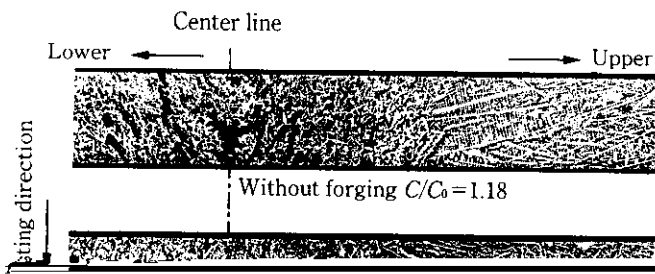
problem of transmission of stress waves in a

U.S. PATENT

Table 2. Experimental conditions of each trial.

Trial	Condition	Duration	Frequency	Intensity
1	Control	10 min	1 time	Low
2	Control	10 min	2 times	Low
3	Control	10 min	3 times	Low
4	Control	10 min	4 times	Low
5	Control	10 min	5 times	Low
6	Control	10 min	6 times	Low
7	Control	10 min	7 times	Low
8	Control	10 min	8 times	Low
9	Control	10 min	9 times	Low
10	Control	10 min	10 times	Low
11	Control	10 min	11 times	Low
12	Control	10 min	12 times	Low
13	Control	10 min	13 times	Low
14	Control	10 min	14 times	Low
15	Control	10 min	15 times	Low
16	Control	10 min	16 times	Low
17	Control	10 min	17 times	Low
18	Control	10 min	18 times	Low
19	Control	10 min	19 times	Low
20	Control	10 min	20 times	Low
21	Control	10 min	21 times	Low
22	Control	10 min	22 times	Low
23	Control	10 min	23 times	Low
24	Control	10 min	24 times	Low
25	Control	10 min	25 times	Low
26	Control	10 min	26 times	Low
27	Control	10 min	27 times	Low
28	Control	10 min	28 times	Low
29	Control	10 min	29 times	Low
30	Control	10 min	30 times	Low
31	Control	10 min	31 times	Low
32	Control	10 min	32 times	Low
33	Control	10 min	33 times	Low
34	Control	10 min	34 times	Low
35	Control	10 min	35 times	Low
36	Control	10 min	36 times	Low
37	Control	10 min	37 times	Low
38	Control	10 min	38 times	Low
39	Control	10 min	39 times	Low
40	Control	10 min	40 times	Low
41	Control	10 min	41 times	Low
42	Control	10 min	42 times	Low
43	Control	10 min	43 times	Low
44	Control	10 min	44 times	Low
45	Control	10 min	45 times	Low
46	Control	10 min	46 times	Low
47	Control	10 min	47 times	Low
48	Control	10 min	48 times	Low
49	Control	10 min	49 times	Low
50	Control	10 min	50 times	Low
51	Control	10 min	51 times	Low
52	Control	10 min	52 times	Low
53	Control	10 min	53 times	Low
54	Control	10 min	54 times	Low
55	Control	10 min	55 times	Low
56	Control	10 min	56 times	Low
57	Control	10 min	57 times	Low
58	Control	10 min	58 times	Low
59	Control	10 min	59 times	Low
60	Control	10 min	60 times	Low
61	Control	10 min	61 times	Low
62	Control	10 min	62 times	Low
63	Control	10 min	63 times	Low
64	Control	10 min	64 times	Low
65	Control	10 min	65 times	Low
66	Control	10 min	66 times	Low
67	Control	10 min	67 times	Low
68	Control	10 min	68 times	Low
69	Control	10 min	69 times	Low
70	Control	10 min	70 times	Low
71	Control	10 min	71 times	Low
72	Control	10 min	72 times	Low
73	Control	10 min	73 times	Low
74	Control	10 min	74 times	Low
75	Control	10 min	75 times	Low
76	Control	10 min	76 times	Low
77	Control	10 min	77 times	Low
78	Control	10 min	78 times	Low
79	Control	10 min	79 times	Low
80	Control	10 min	80 times	Low
81	Control	10 min	81 times	Low
82	Control	10 min	82 times	Low
83	Control	10 min	83 times	Low
84	Control	10 min	84 times	Low
85	Control	10 min	85 times	Low
86	Control	10 min	86 times	Low
87	Control	10 min	87 times	Low
88	Control	10 min	88 times	Low
89	Control	10 min	89 times	Low
90	Control	10 min	90 times	Low
91	Control	10 min	91 times	Low
92	Control	10 min	92 times	Low
93	Control	10 min	93 times	Low
94	Control	10 min	94 times	Low
95	Control	10 min	95 times	Low
96	Control	10 min	96 times	Low
97	Control	10 min	97 times	Low
98	Control	10 min	98 times	Low
99	Control	10 min	99 times	Low
100	Control	10 min	100 times	Low





carbon segregation at the bloom center shows little

A continuous forging method was developed with the aim of improving centerline segregation in continuously cast blooms. In this method, anvils are used to apply

gation remained virtually unchanged with fluctuations in casting speed equivalent to an approximately 1 min stop of casting, confirming the stability of